

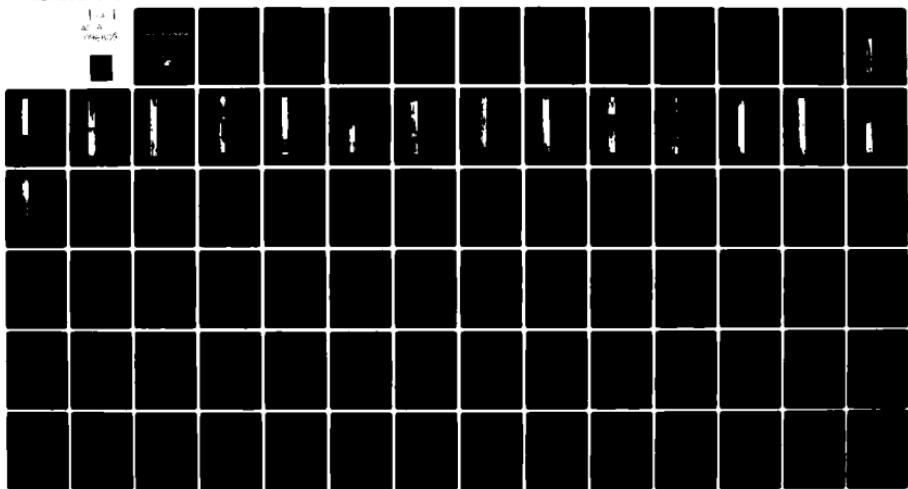
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TRACALS EVALUATION REPORT, COMMUNICATIONS INITIAL EVALUATION RE--ETC(U)
FEB 81 R S ANTONIO, P M DERMODY

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TRACALS EVALUATION REPORT

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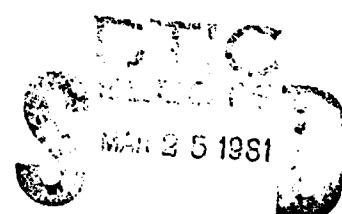
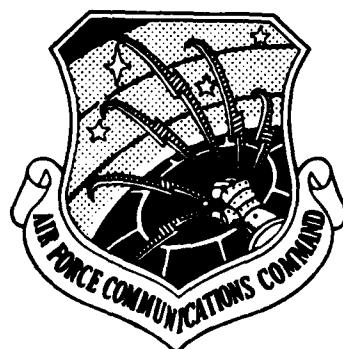
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COMMUNICATIONS INITIAL EVALUATION REPORT

Luke AFB, Arizona

80/66C-231

29 September - 8 October 1980



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DEPARTMENT OF THE AIR FORCE
1866 Facility Checking Squadron
Scott AFB, Illinois 62225

27 February 1981

COMMUNICATIONS INITIAL EVALUATION REPORT

Luke AFB, Arizona

80/66C-231

29 September - 8 October 1980

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Commander

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| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Traffic Control and Landing Systems (TRACALS) Air Traffic Control (ATC) Communications System Evaluation | | |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A Communications Initial Evaluation was performed at Luke AFB, Arizona from 29 September to 8 October 1980. The purpose was to define the capabilities and limitations of the ATC communications system. This report includes the analysis and results of ground equipment and system measurements, and the correlation of predicted and measured received signal levels which defines horizontal and vertical coverage. This report can be used as a guide for anticipated performance of the ATC communications system until a deletion, addition, relocation of equipment, or a change occurs in the horizon profile. | | |

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SUMMARY

1. Evaluation Profile. This evaluation was conducted to define the capabilities and limitations of the Air Traffic Control (ATC) Communications System in its installed environment at Luke AFB, Arizona. This evaluation was accomplished in two phases: a ground phase and a flight phase. The ground phase consisted of extensive testing of a representative sample of the ATC communications equipment. The ground phase also included commercial/backup power system checks and site surveys. The ground equipment checks are designed to eliminate equipment degradation as a factor which might adversely affect the data gathered during the flight phase. The flight phase consisted of radial and orbital tracks flown from the Luke AFB Tactical Air Navigation (TACAN) facility by the flight inspection aircraft while received signal levels (RSLs) were recorded on the ground and in the aircraft. Analysis of the recorded data provides a composite, three-dimensional picture of the communications coverage for the Luke AFB Operational Area.

2. ATC Communications System:

a. Equipment Performance. Equipment tests were accomplished using procedures described in the equipment technical order (TO). Where no procedures are given, AFCCP 100-61, Vol XIII was used as guidance. Equipment specifications and test results are contained in Attachments 8 thru 13. The majority of the equipment checked was providing adequate service; however, several areas require special attention.

(1) All transmitters evaluated were below TO specification on power output. Power output level measurements ranged from 6.8 to 8.0 watts. All transmitters were adjusted to the TO specification of 10 watts. Low power output will decrease communications coverage.

(2) Five antenna multicoupler cavities at the transmitter site and thirteen antenna multicoupler cavities at the receiver site exceeded the maximum insertion loss of 2 dB specified by the TO. Eight of the antenna multicoupler cavities, one at the transmitter site and seven at the receiver site, remained out of tolerance after retuning. Any insertion loss reduces communications coverage.

(3) All multichannel transceivers and two single channel transmitters were out of specification on percent of modulation. The radios were adjusted to TO specification with the exception of two Very High Frequency (VHF) transceivers. These transceivers required internal adjustments and were turned over to local maintenance for corrective action.

(4) Four PP-4558G Power Supply modules in the ground control approach (GCA) four channel communications control system were found to have a high ripple voltage on the regulated -28 volt DC output. Although three power supplies were not yet affecting noise levels in the audio frequency (AF) amplifiers, the fourth power supply was causing high noise levels in one bank of AF amplifiers. Although there are no procedures in the equipment TO or equipment workcards for checking the ripple voltages in the PP-4558G Power Supplies; the power supplies were determined to be defective by first measuring noise levels in the AF amplifiers, then replacing the power supply with one having almost no ripple voltage and measuring the noise levels again.

Following this procedure, one power supply was found to be causing excessive noise levels in the AF amplifiers. Replacing the power supply decreased the noise levels more than 40 dB.

b. Evaluation Results. Terrain surrounding the ground antennas appears conducive to adverse multipath propagations which created significant nulling along some azimuths. For example, on the 208 and 310 radials, measured RSLs clearly showed deep nulling at predicted null locations (see Attachment 6 and pages A16-5 and A16-7). Also during orbital track 8, recorders at the receiver site and the GCA facility indicated a loss of signal for a 20 degree sector between 355° and 015° . These losses of reception on the orbital track were due to adverse multipath propagations rather than any RLOS limitations. It should be noted that during the orbital flight between 355° and 015° , the flight check aircraft had actually ascended to 5200 feet mean sea level (MSL) and placed itself near predicted null locations (see Attachments 6 and 14). Reduced communications range due to horizon screens are evident in recorded data. Surveys conducted at the transmitter and receiver sites show significant screening in the sectors between 138° to 164° and 230° to 300° (see Attachment 7). These screening angles can severely limit coverage at the minimum vectoring altitude (MVA). For example, on the 270 radial, screening angles measured 2.5° for the transmitter site and 2.2° for the receiver site. At the MVA of 5200 feet MSL, actual range of communications was 17 nautical miles (NM) for the transmitter site and 18 NM for the receiver site.

c. Capabilities and Limitations. Although radio coverage is adequate for most of Luke AFB's operating airspace, some limitations in coverage exist. Attachment 6 illustrates the predicted null locations due to multipath propagation. Severity of these nulls along different azimuths vary with the type of reflecting terrain about the ground antennas. In the sector between 230° and 300° , terrain screening reduces communications range at the MVA to 13 NM of Luke AFB. In the sector between 138° to 161° , range of communications at the MVA is reduced to 25 NM of Luke AFB. From analysis of data gathered on 20 NM arcs flown in the vicinity of Luke Auxiliary Field # 1 and site surveys of screening angles, primary communications is determined to be available down to 1000 feet AGL at 20 NM from 303° to 346° . GCA backup communications to the Auxiliary Field #1 is available down to 1000 feet AGL at 20 NM from 300° to 330° . The control tower screens the GCA backup communications in a 13° sector from 360° to 013° (see Attachment 7).

3. Power Systems. Commercial and backup power was adequate and reliable at all facilities. Backup power at the transmitter site was being temporarily provided by a portable generator.

RECOMMENDATIONS

1. ATC Communications System. Recommend revision of published MVAs to coincide with communications coverage capability.

2. Power Systems. No recommendations.

PERFORMANCE PREDICTIONS. Existing communications capabilities and limitations should continue unless there is an addition, deletion, relocation of equipment, or a change in horizon profile.

Attachment 1

A1-1

TITLE: GEOGRAPHIC LOCATION

LOCATION: Luke AFB

DATE: September 1980

Scale: 1:500,000

Magnetic Variation: 13° East

AFCS FORM MAY 73 906

Magnetic Variation: 13° East

TITLE

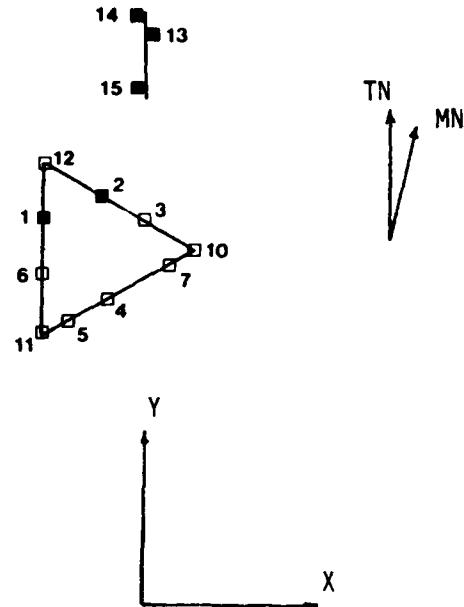
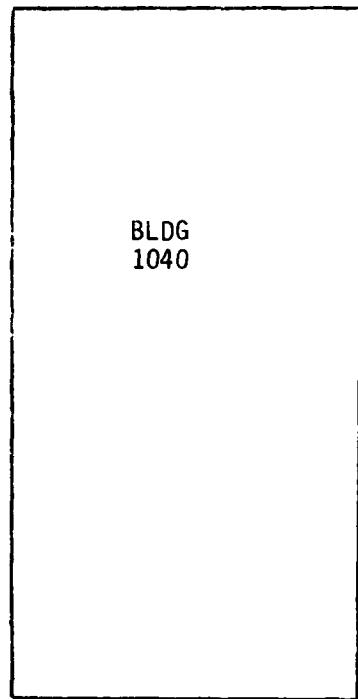
TRANSMITTER SITE ANTENNA LAYOUT/DATA

LOCATION

Luke AFB

DATE

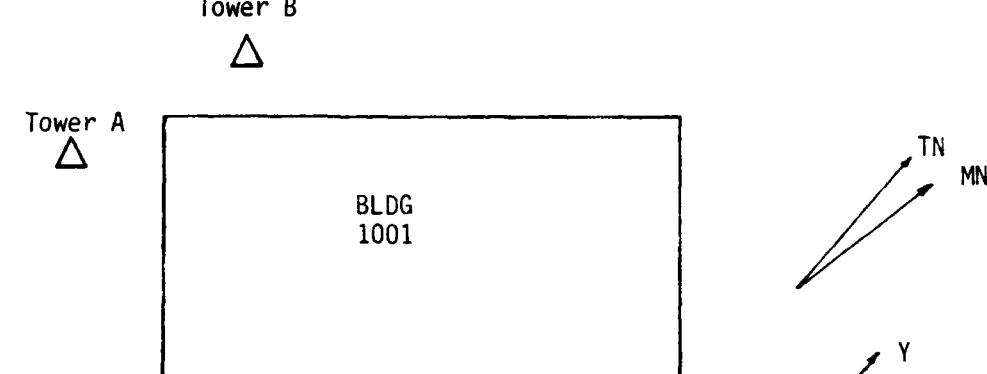
September 1980



| ANTENNA | X | Y | ANTENNA COORDINATES (ft) Z(AGL) | ANTENNA TYPE | FREQ (MHz) |
|---------|---------------|--------|------------------------------------|-----------------|-------------------------|
| 1 | 0 | 0 | 23.87 | AS-1181 | 126.2 |
| 2 | 7.42 | 0.39 | 23.52 | AS-1181 | 121.5 |
| 3 | 13.84 | -1.68 | 23.39 | AS-1097 | 395.0/289.6/243.0/335.8 |
| 4 | 11.86 | -11.20 | 23.41 | AS-1097 | Spare |
| 5 | 6.76 | -16.01 | 23.42 | AS-1097 | Spare/337.7/242.3/375.2 |
| 6 | 1.20 | -6.78 | 23.50 | AS-1097 | 296.1/325.9/266.4/372.2 |
| 7 | 17.62 | -6.57 | 23.41 | AS-1097 | Spare |
| 8 | NOT AVAILABLE | | | AT-197 | Spare |
| 10 | 19.96 | -4.07 | 40.77 | AS-1097 | 349.7/389.8/301.5/316.9 |
| 11 | 4.00 | -17.41 | 41.83 | AS-1097 | 291.1/372.9/269.9/Spare |
| 12 | -0.65 | 2.07 | 31.42 | AS-1097 | 311.2/257.2/349.0/388.9 |
| 13 | 10.79 | 41.84 | 40.22 | AS-1181 | 134.1 |
| 14 | 10.48 | 41.84 | 50.78 | AS-1181 | Spare |
| 15 | 11.45 | 31.42 | 50.56 | AS-1181 | 120.5 |

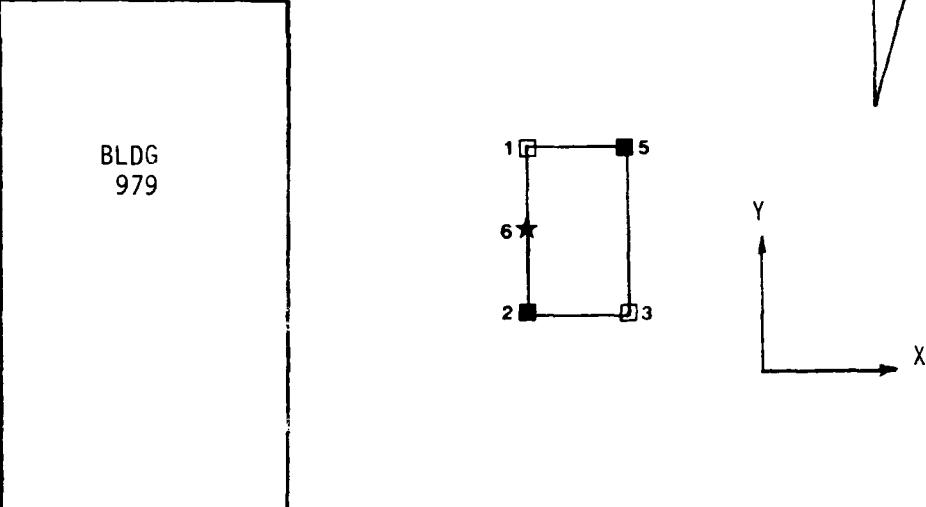
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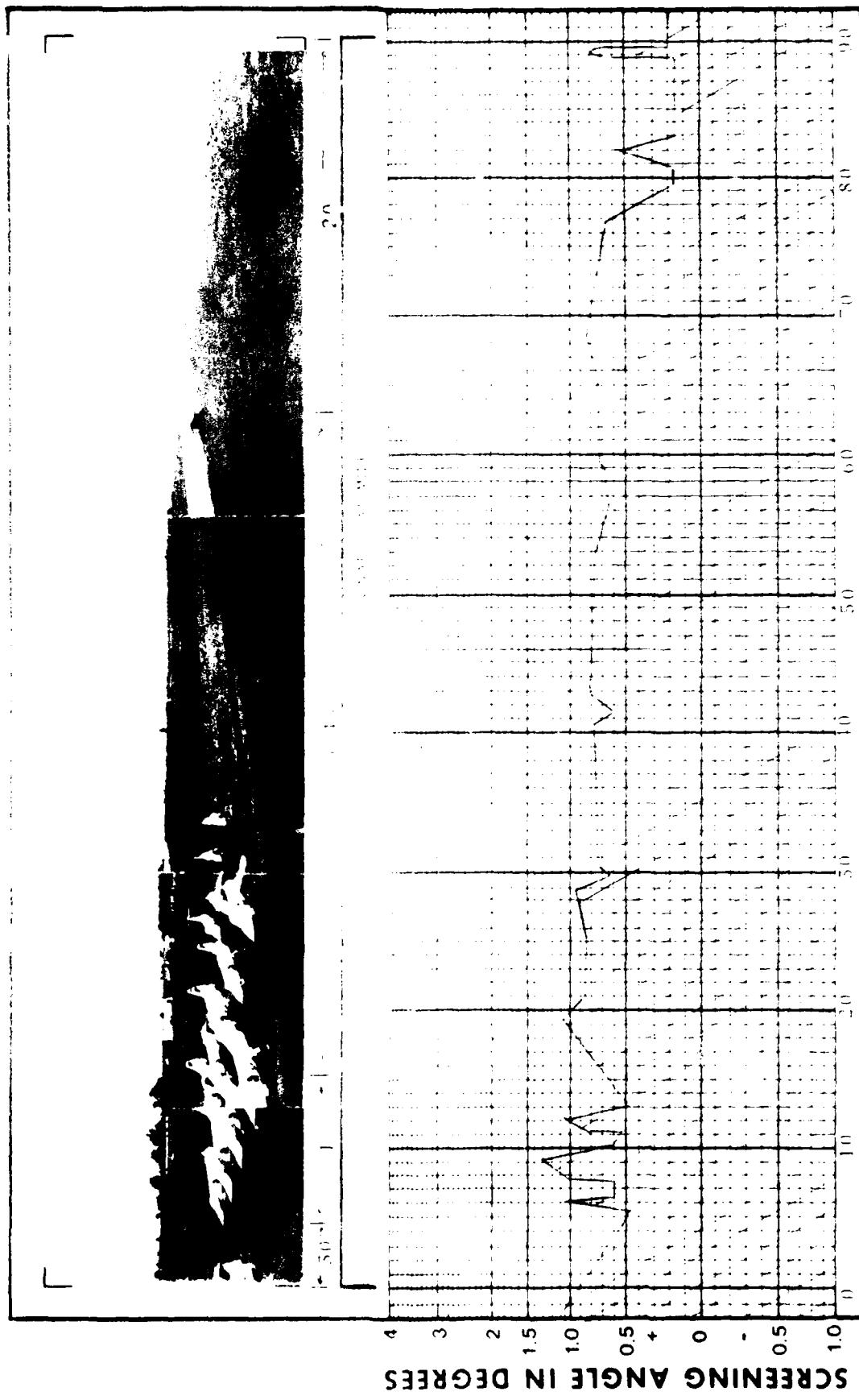
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|--|------------------------|--------|------------------------------------|--------------|-------------------------|
| RECEIVER SITE ANTENNA LAYOUT/DATA | | | | | |
| LOCATION Luke AFB | DATE September 1980 | | | | |
|  | | | | | |
| | | | | | |
| ANTENNA | X | Y | ANTENNA COORDINATES (ft) Z(AGL) | ANTENNA TYPE | FREQ (MHz) |
| A-1 | 20.41 | -29.40 | 71.75 | AS-1181 | 134.1 |
| A-2 | 18.33 | -37.53 | 71.68 | AS-1181 | 121.5 |
| A-3 | 10.40 | -35.69 | 71.73 | AS-1181 | 126.2 |
| A-4 | 11.98 | -27.45 | 71.68 | AS-1181 | 120.5 |
| A-5 | 15.23 | -32.01 | 73.39 | AS-1181 | Spare |
| B-1 | 0 | 0 | 71.70 | AT-197 | 395.0/289.6/256.9/243.0 |
| B-2 | 6.41 | -4.77 | 71.81 | AT-197 | 335.8/349.7/389.8/301.5 |
| B-3 | 10.94 | -1.32 | 71.39 | AT-197 | 337.7/242.3/375.2 |
| B-4 | 4.77 | 6.15 | 71.65 | AT-197 | 296.1/325.9/266.4/372.2 |
| B-5 | 5.96 | 0.68 | 73.08 | AT-197 | 257.2/349.0/388.9/311.2 |
| B-6 | 0.14 | -3.44 | 58.35 | AT-197 | 316.9/291.1/372.9 |
| B-7 | 11.50 | -2.28 | 56.67 | AT-197 | Spare |
| B-8 | 10.06 | 5.41 | 56.65 | AT-197 | Spare |

REMARKS

Site Elevation: 1074 feet MSL

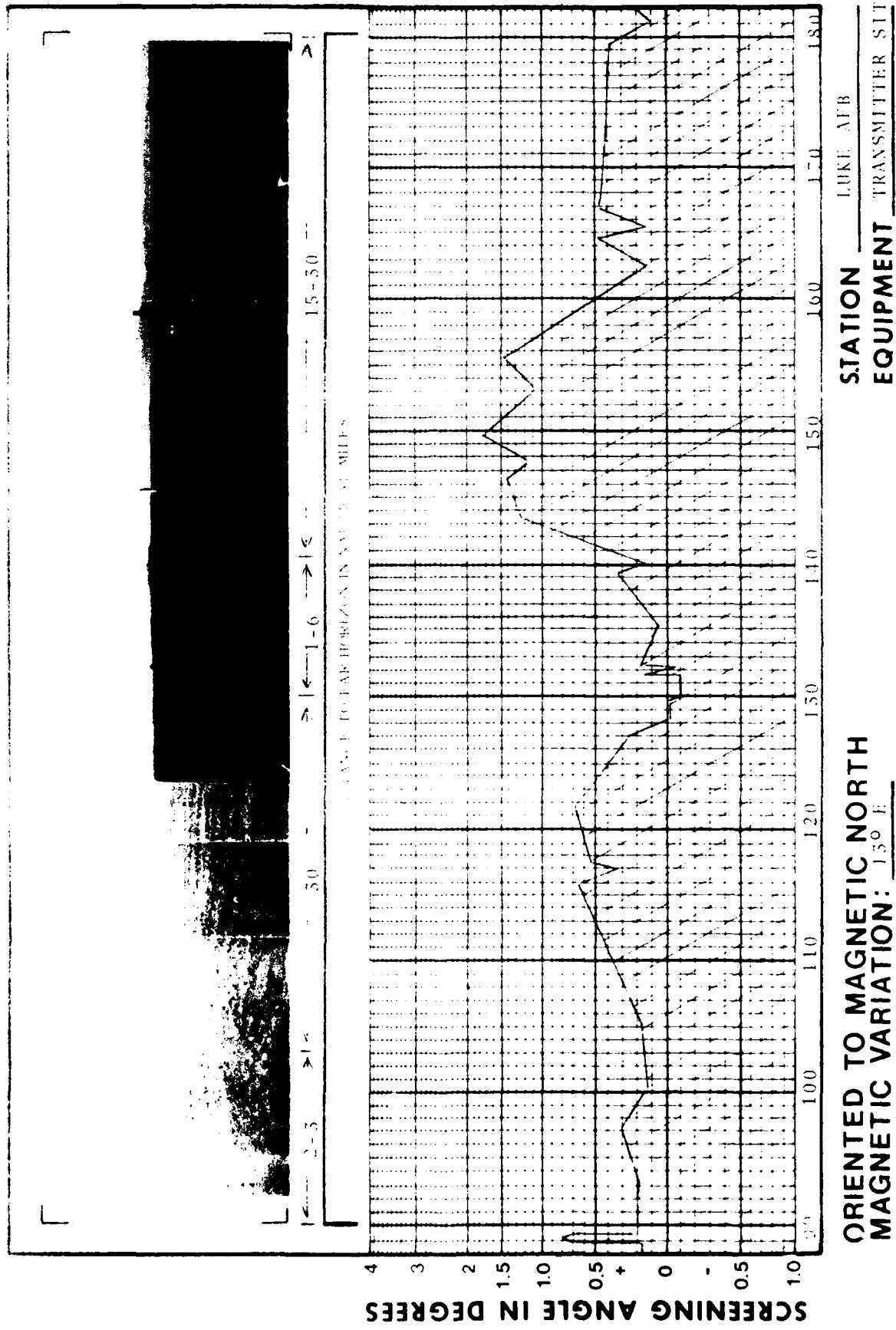
| TITLE | | | | | |
|--|--------------------------|--------|--------|--------------|------------------|
| GCA ANTENNA LAYOUT/DATA | | | | | |
| LOCATION | DATE | | | | |
| Luke AFB | September 1980 | | | | |
|  | | | | | |
| ANTENNA | ANTENNA COORDINATES (ft) | | | TYPE ANTENNA | FREQ (MHz) |
| | X | Y | Z(AGL) | | |
| 1 | 0 | 0 | 56.14 | AS-1097 | 349.7 |
| 2 | 3.60 | -14.37 | 54.93 | AS-1181 | VHF Multichannel |
| 3 | 10.58 | -12.62 | 56.22 | AS-1097 | UHF Multichannel |
| 5 | 7.01 | 1.76 | 54.93 | AS-1181 | 120.5 |
| 6 | 1.72 | -6.87 | 54.98 | AT-197 | Spare |
| REMARKS | | | | | |
| Site Elevation: 1080 feet MSL | | | | | |

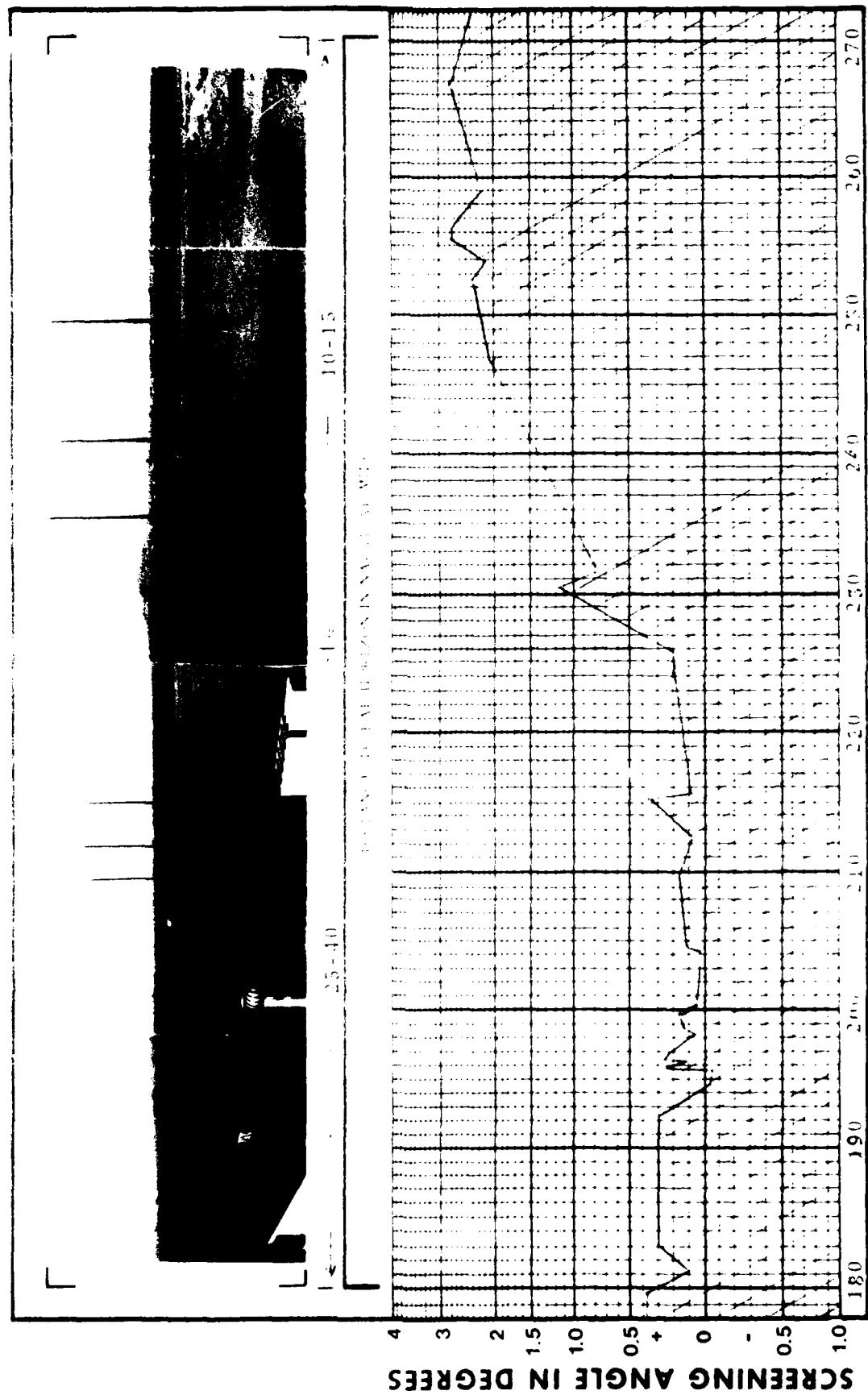
SKYLINE GRAPH



S.TATION 101KL ALB
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SKYLINE GRAPH

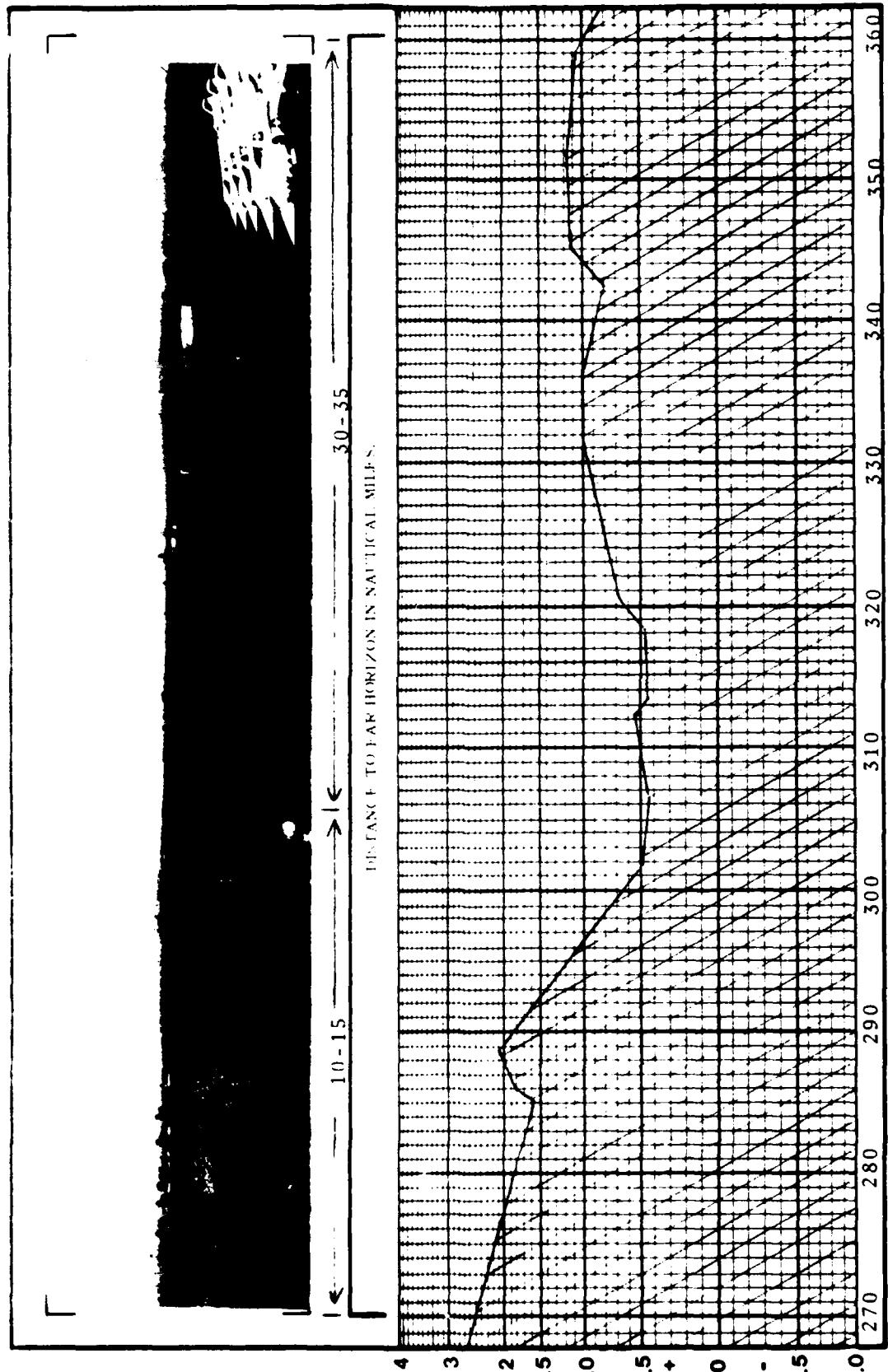




ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 150

STATION LUKE AFB
EQUIPMENT TRANSMITTER SITE

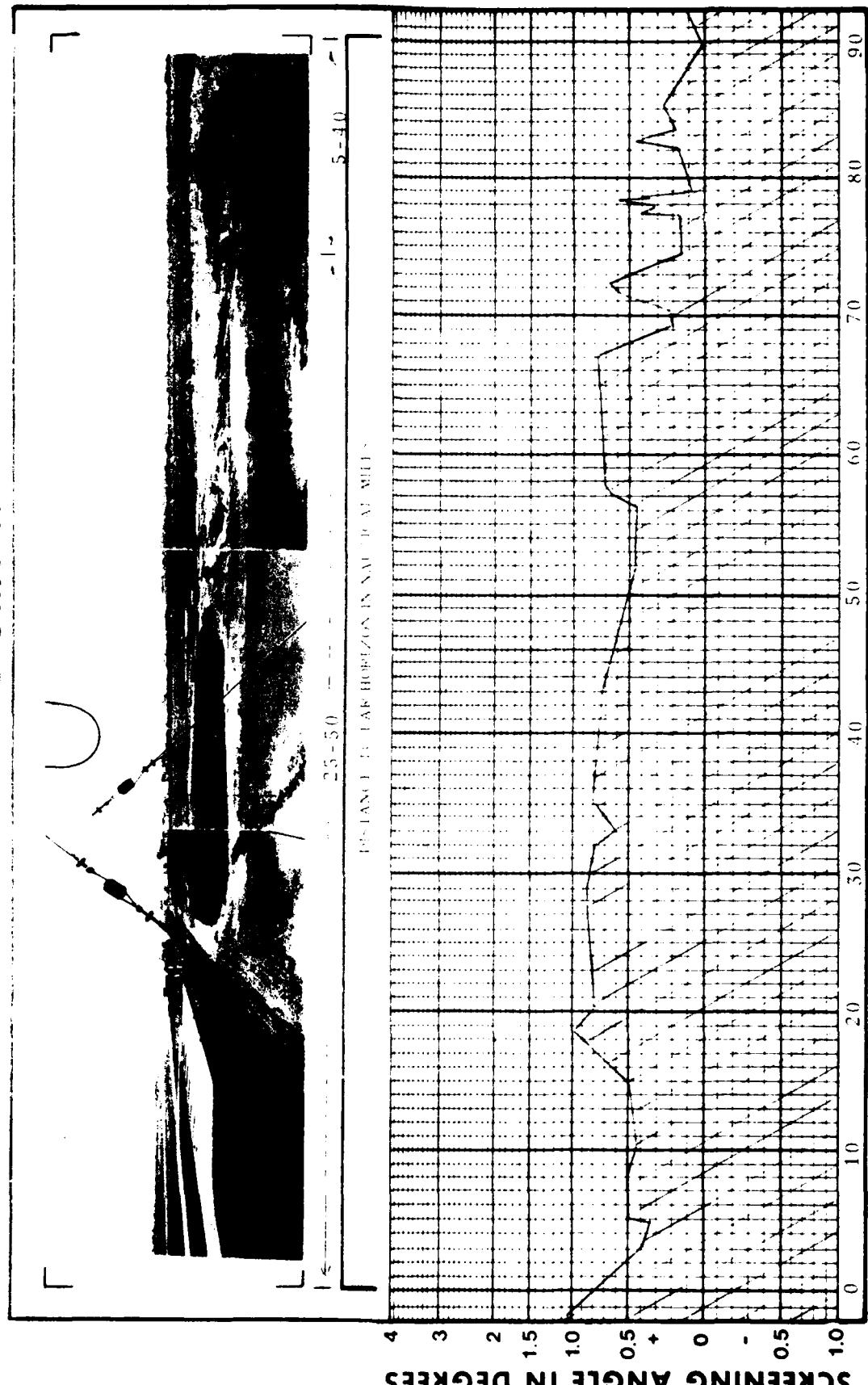
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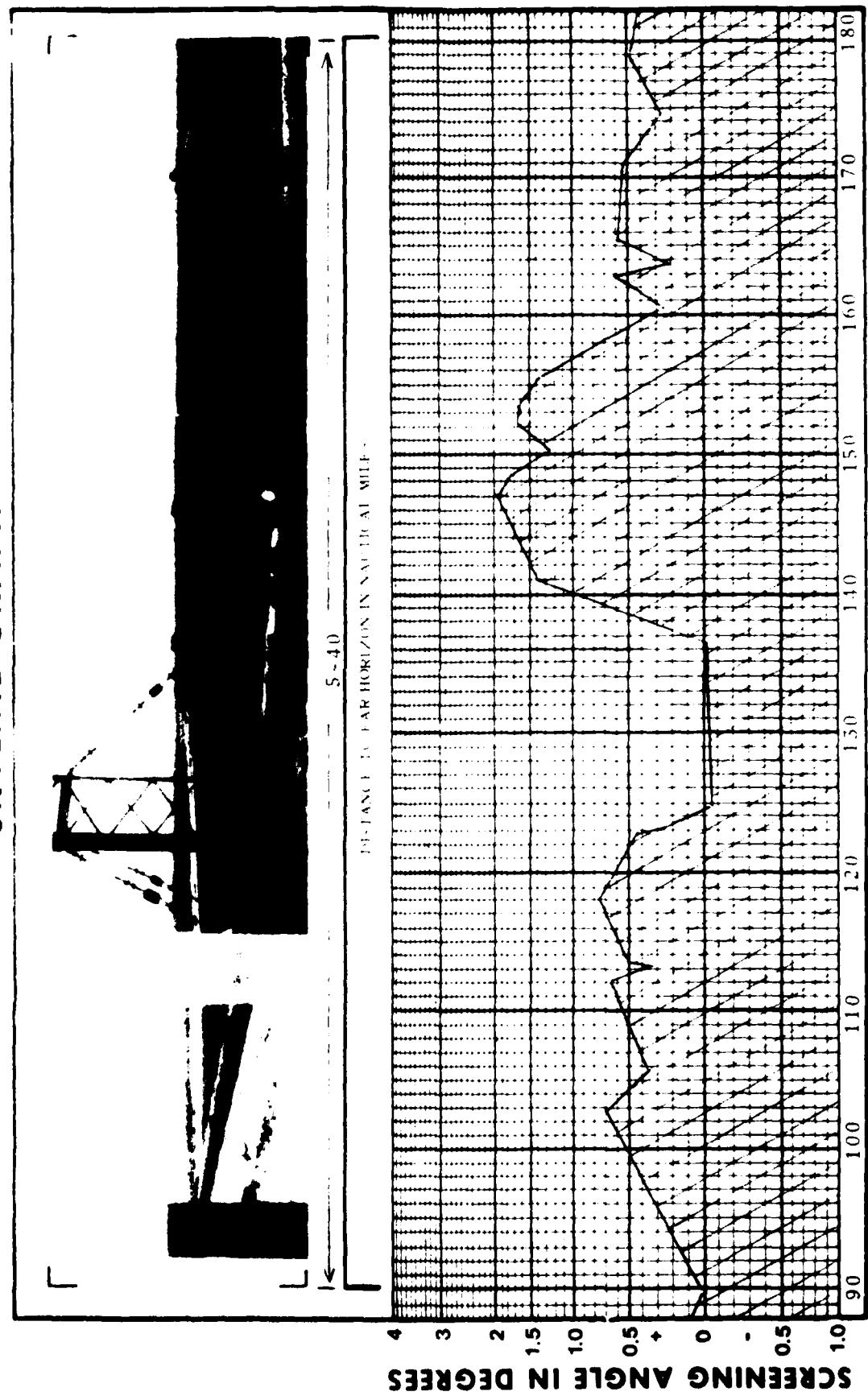
STATION LUKE AFB
EQUIPMENT TRANSMITTER SITE

SKYLINE GRAPH



STATION LUKE AFB
EQUIPMENT RECHIVER SITE

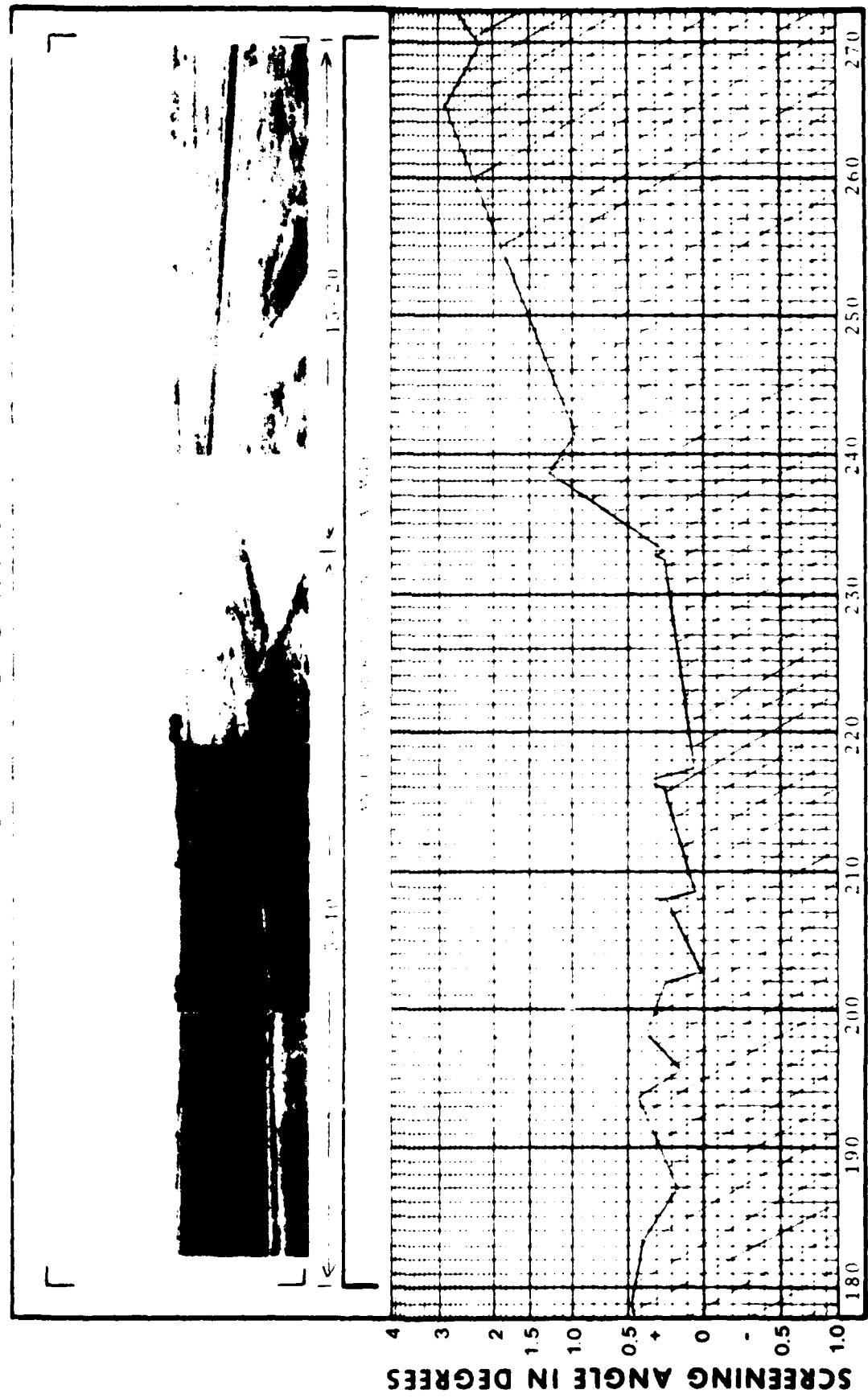
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ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 130° E

STATION LUKE AIR
EQUIPMENT RECEIVER SITE

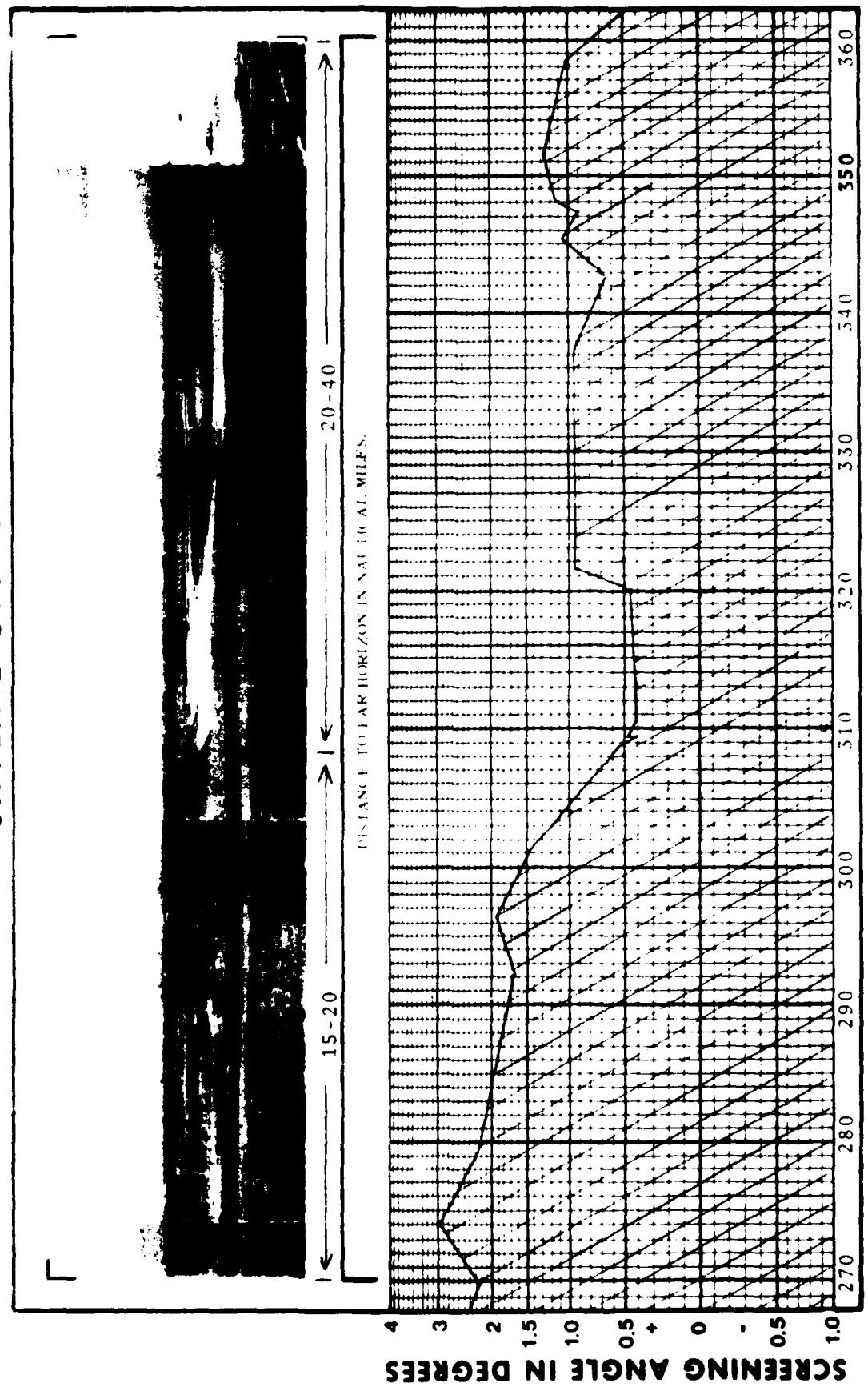
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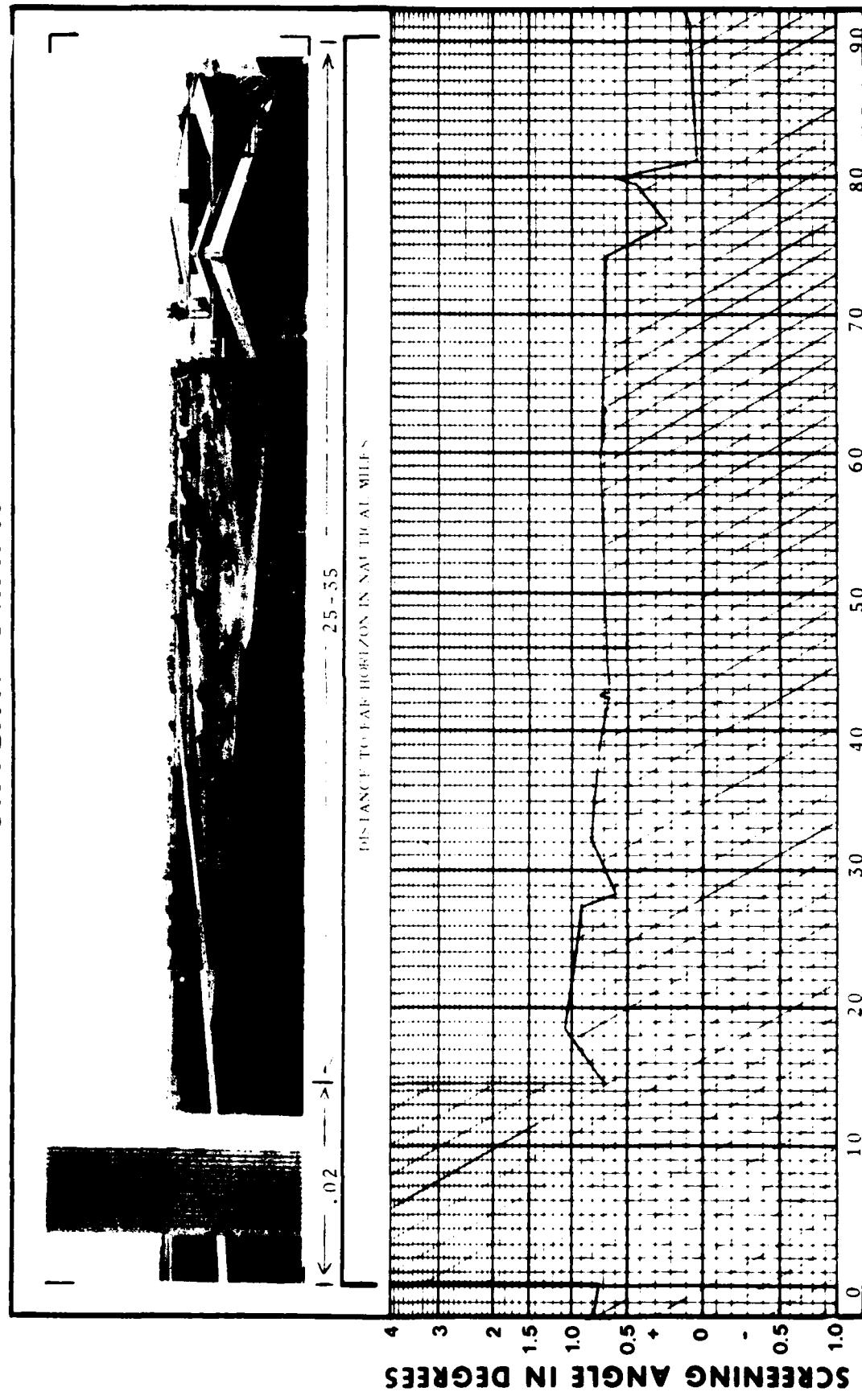
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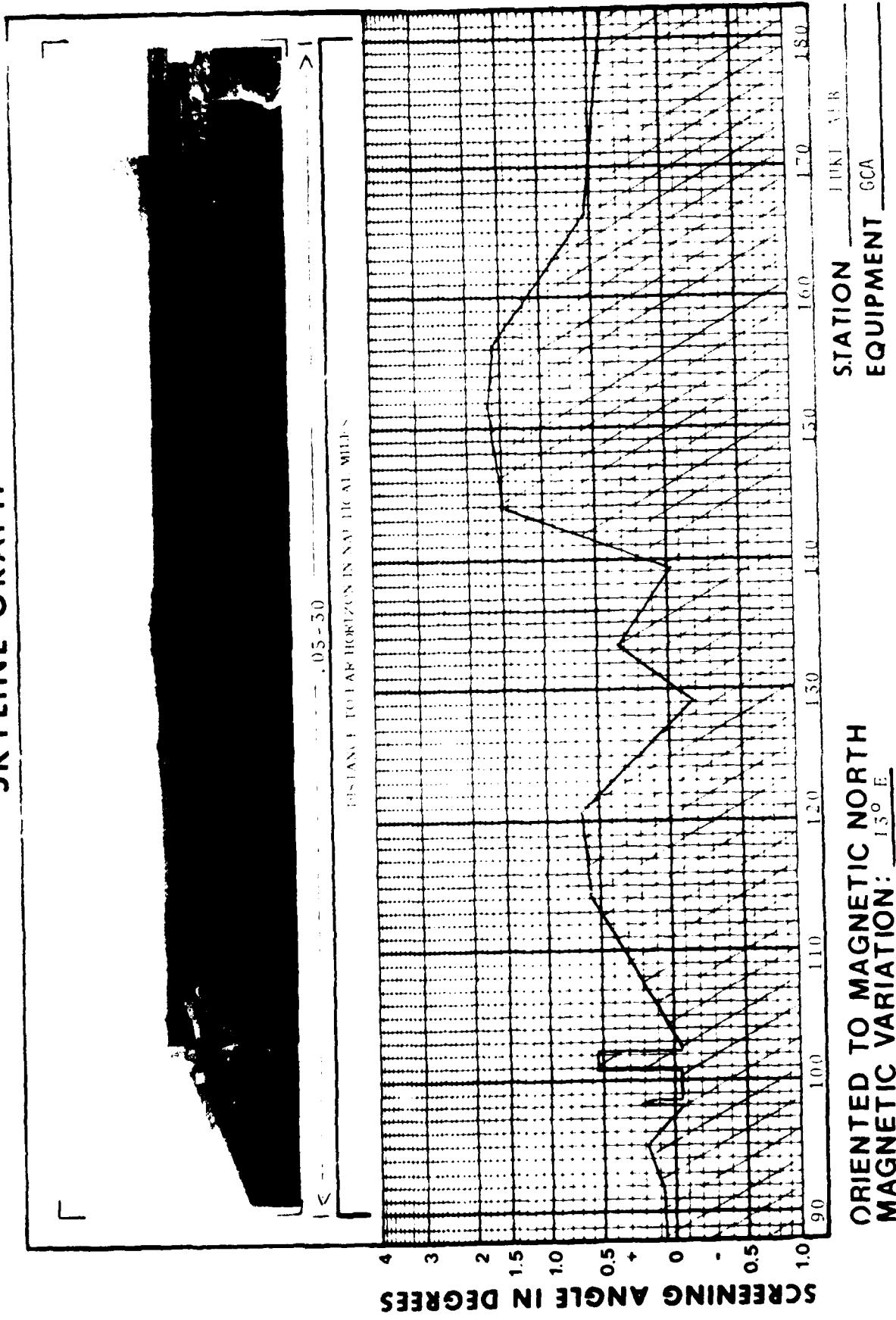


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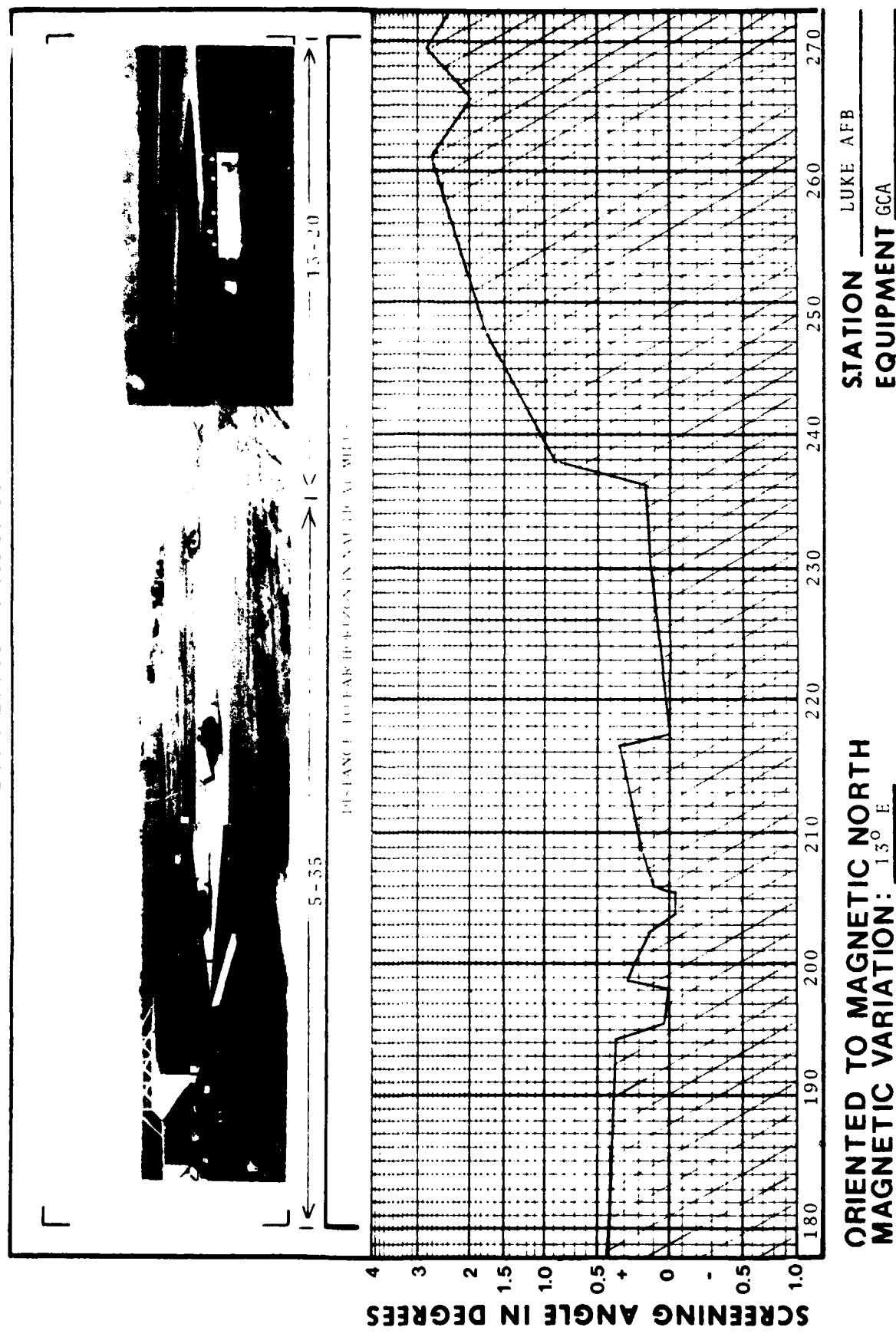
STATION LUKE AFB
EQUIPMENT RECEIVER SITE

SKYLINE GRAPH

SKYLINE GRAPH



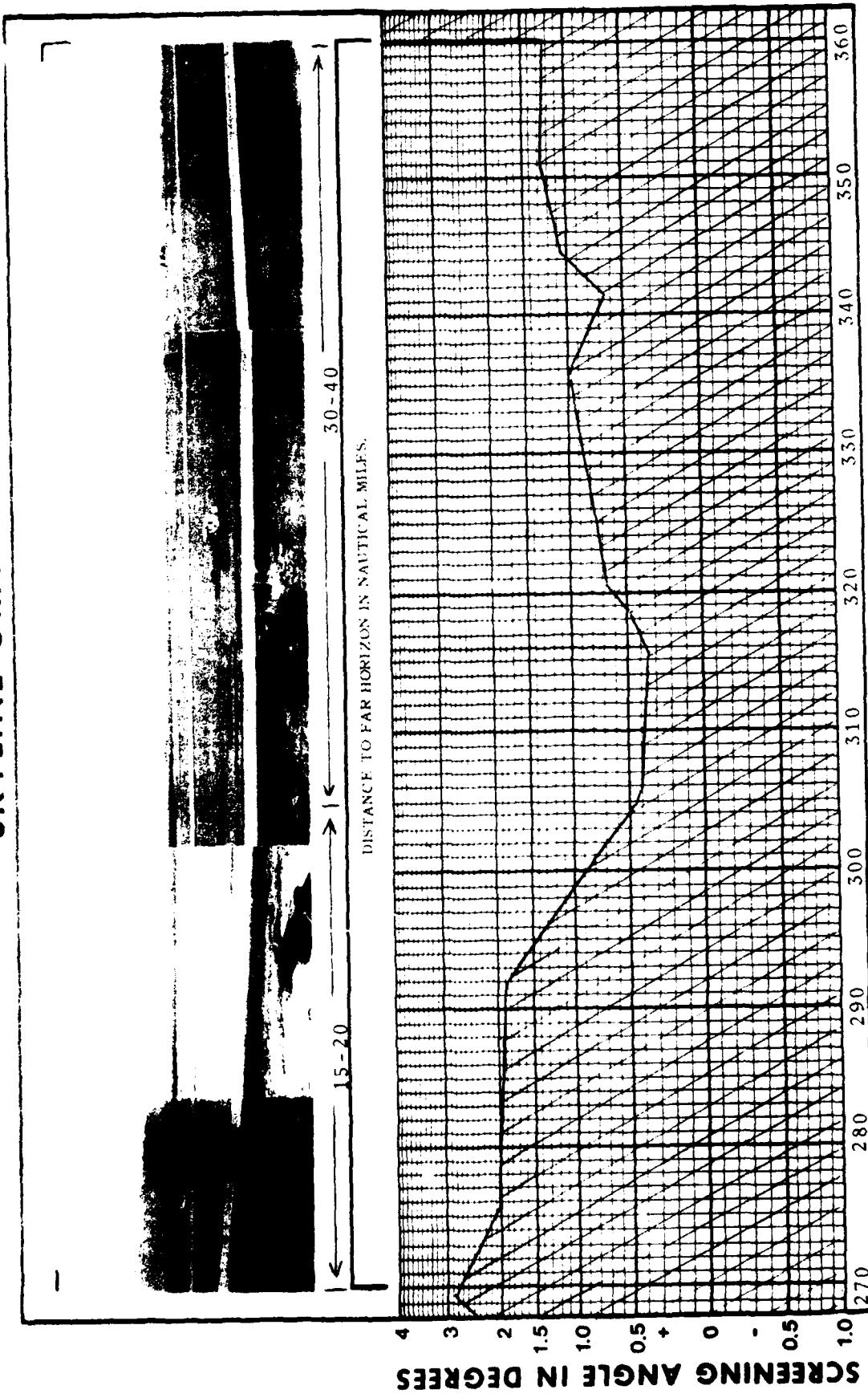
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MAGNETIC VARIATION: 13° E

STATION LUKE AFB
EQUIPMENT GCA

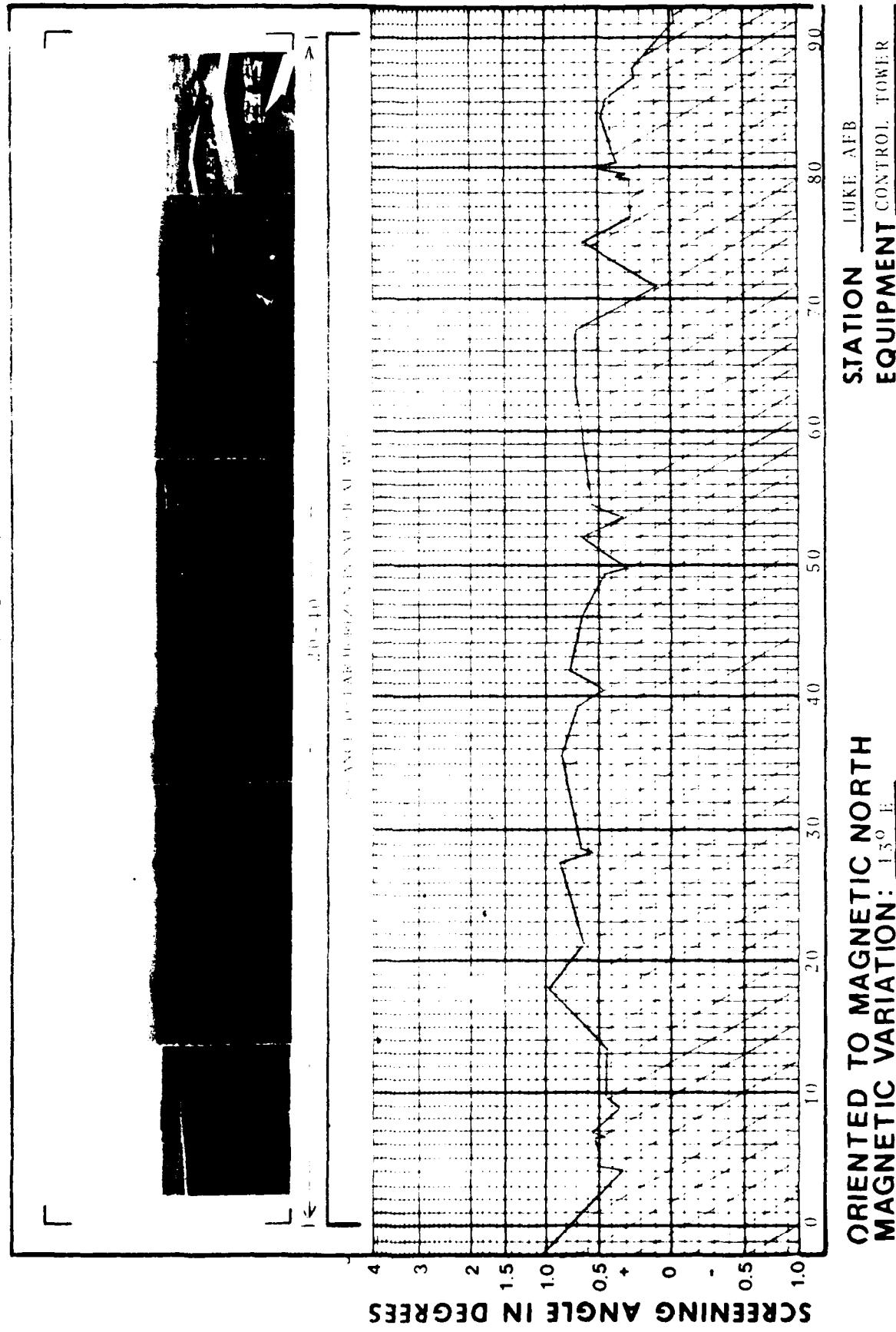
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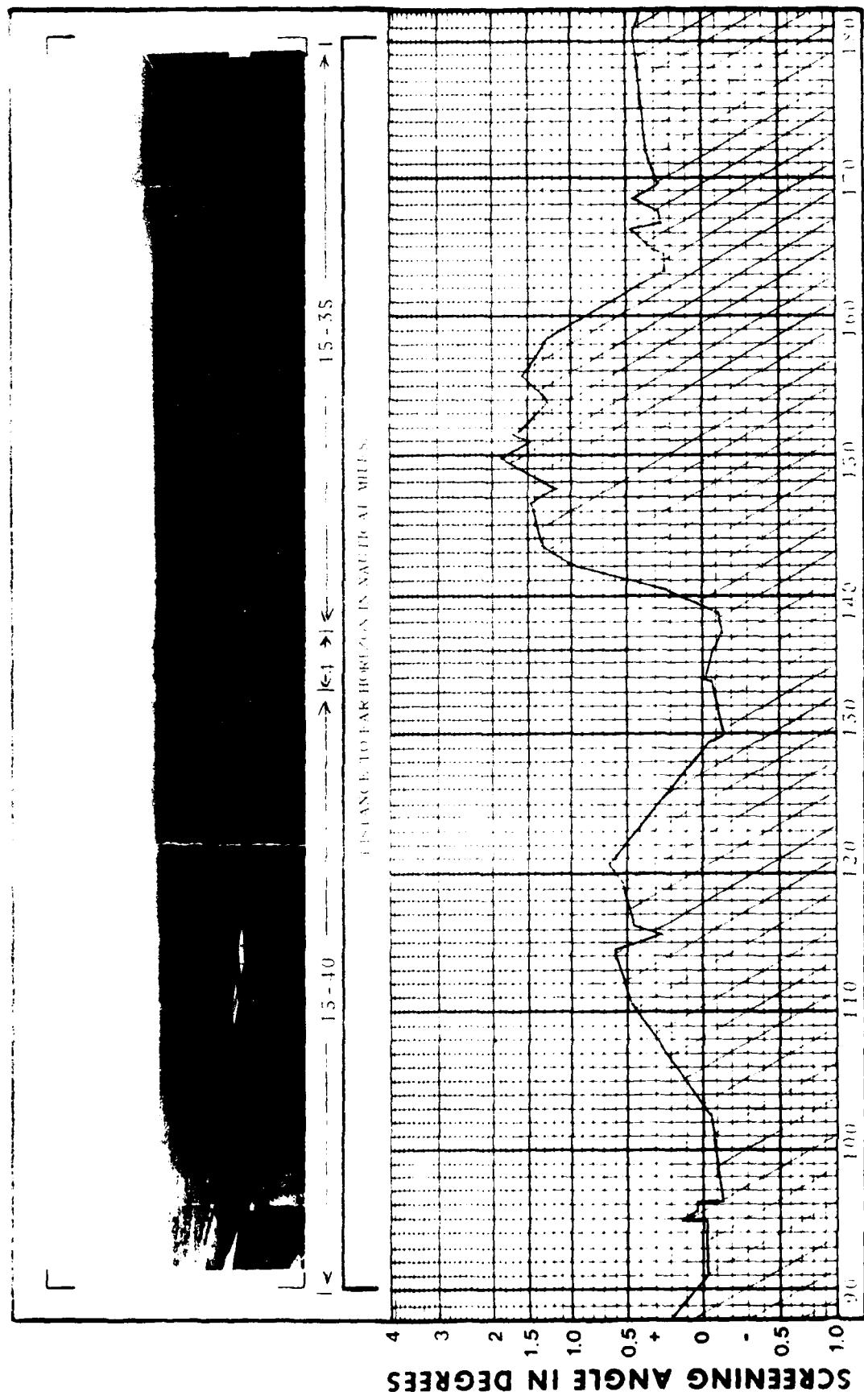
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STATION LUKE AFB
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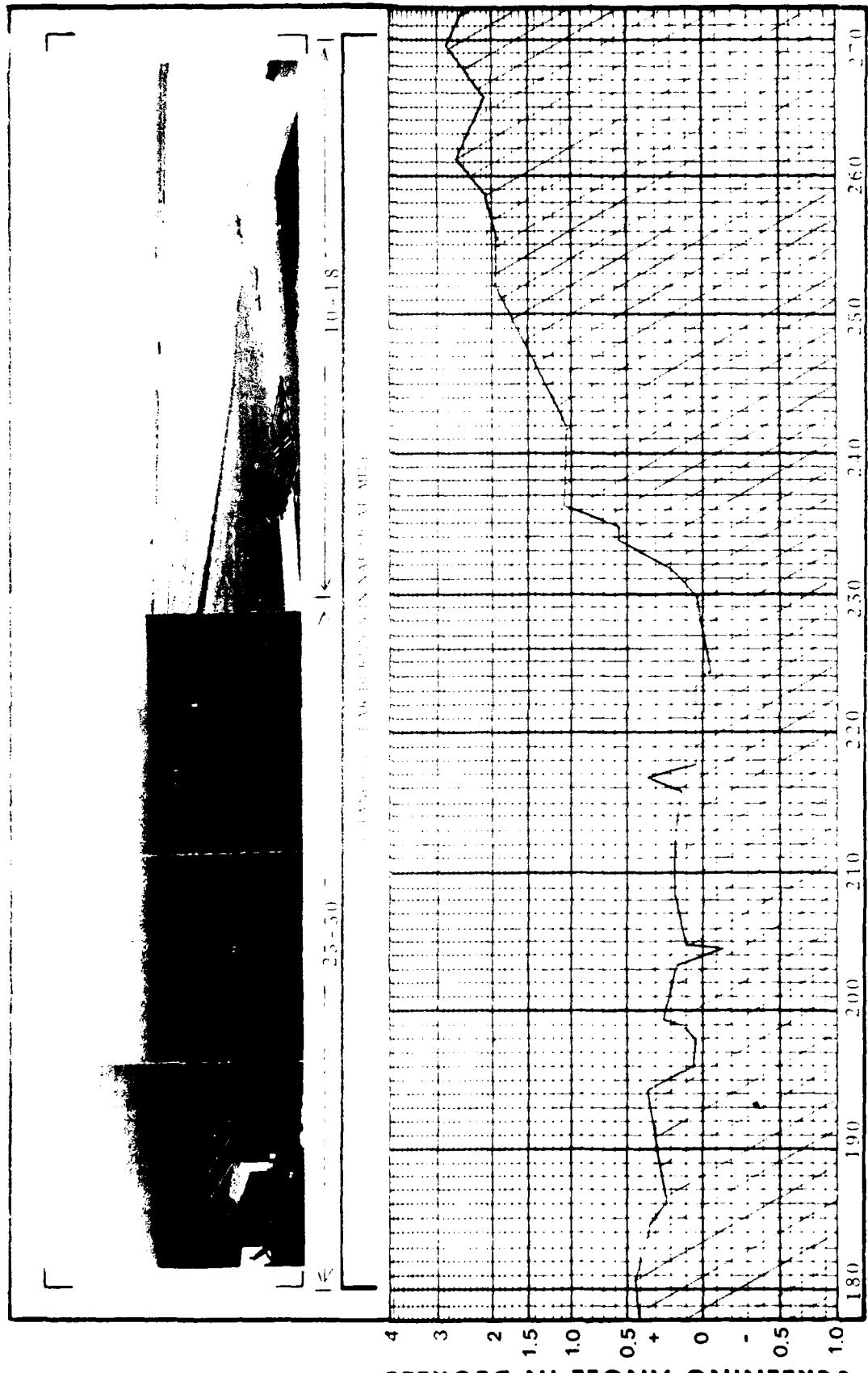
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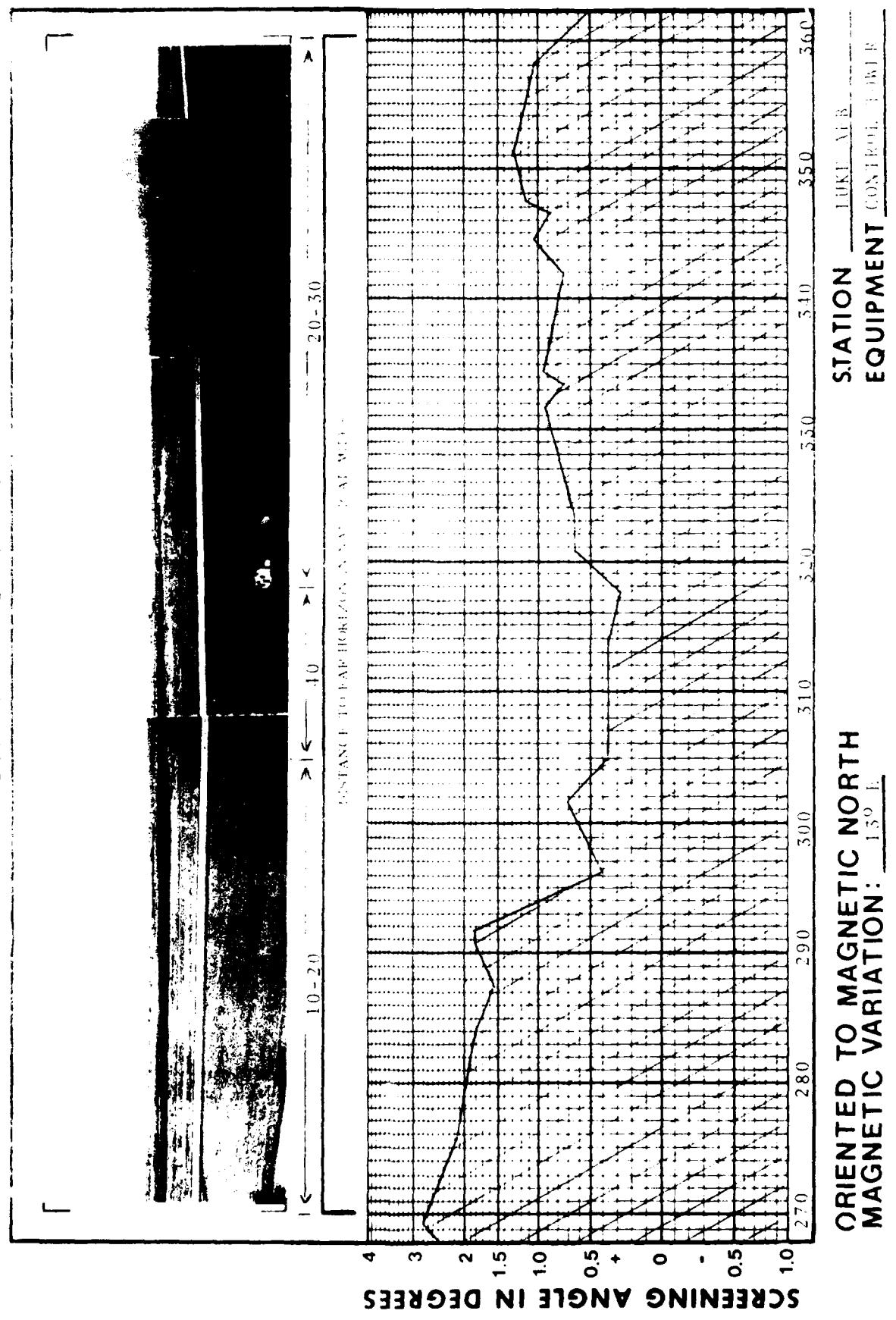


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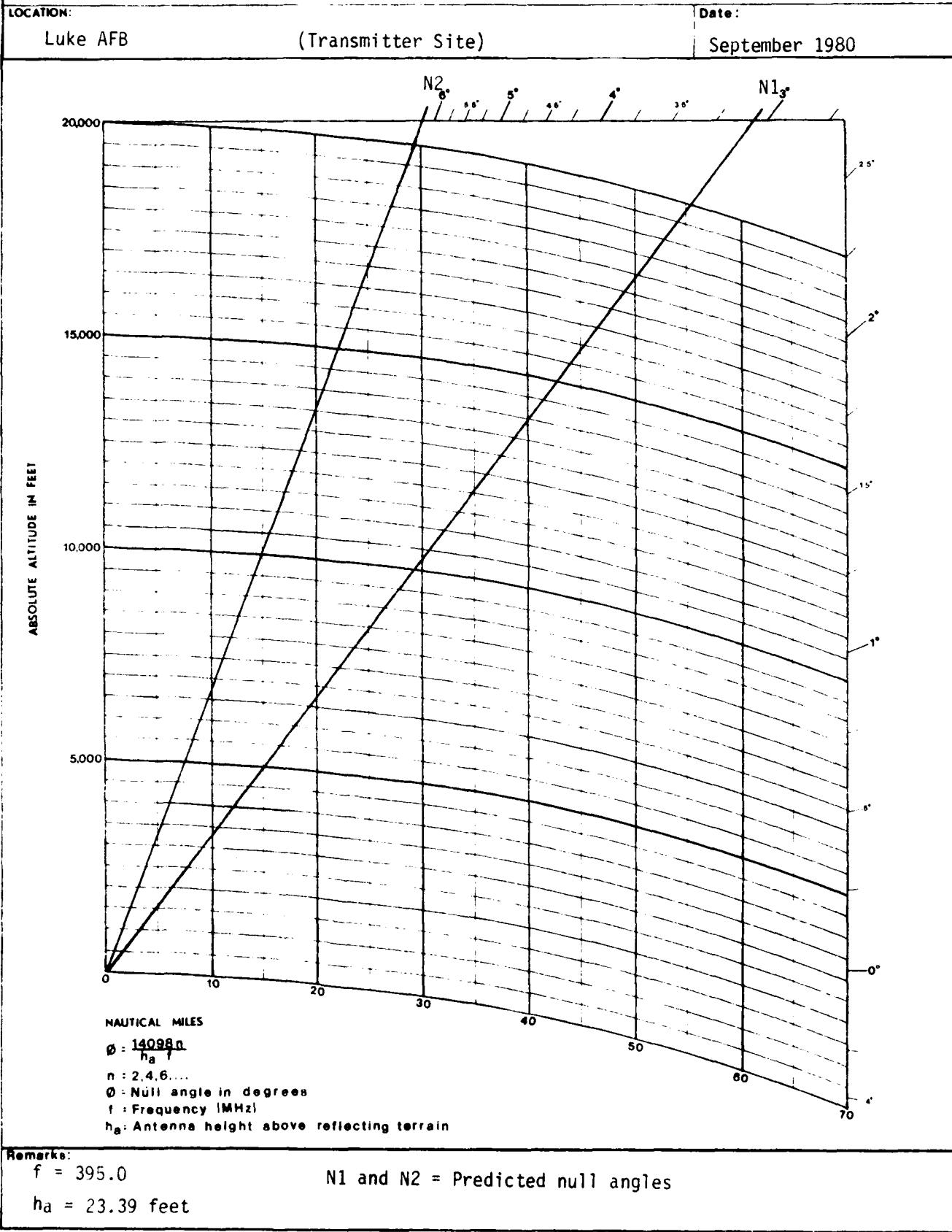


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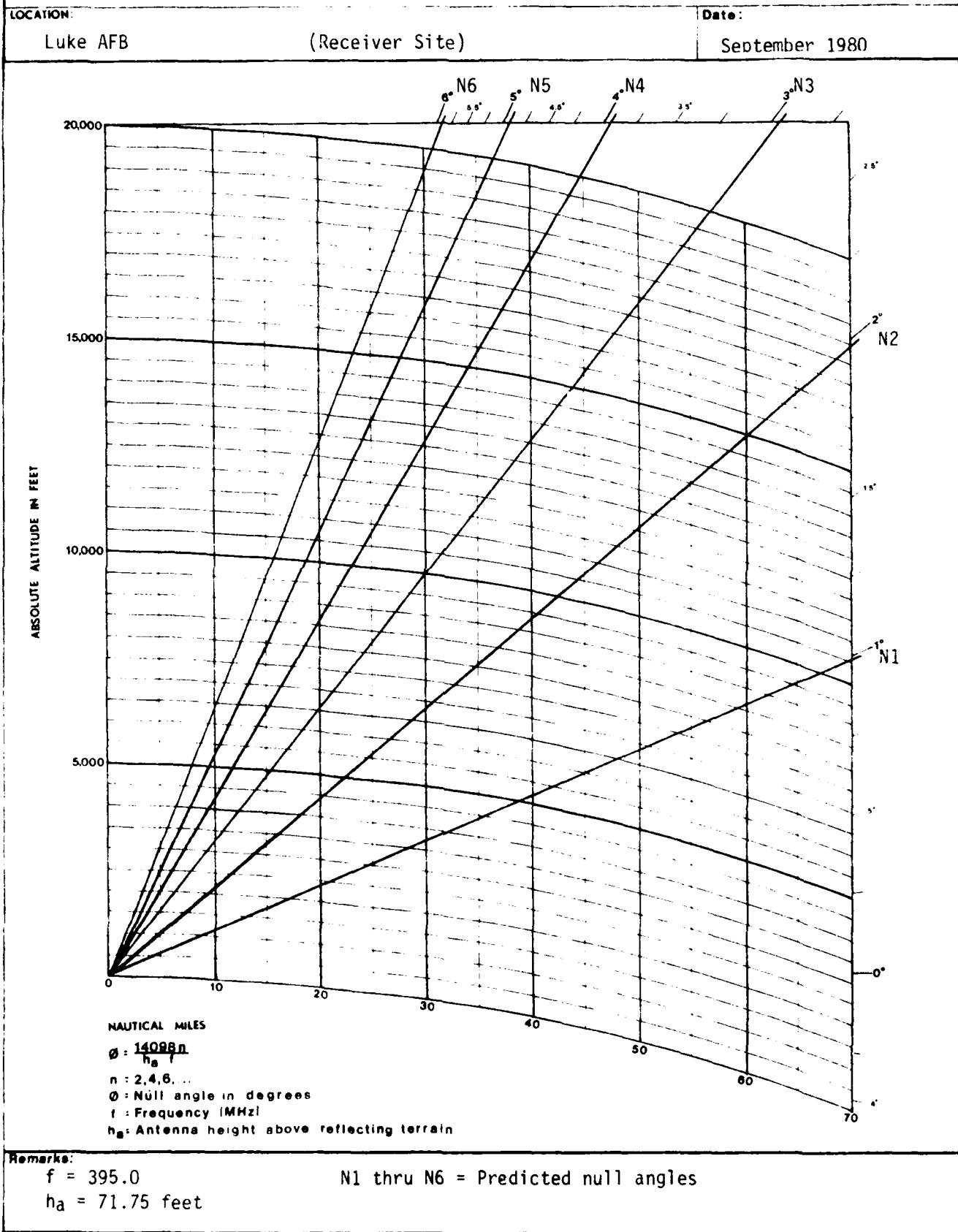
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EQUIPMENT CONTROL PLATE



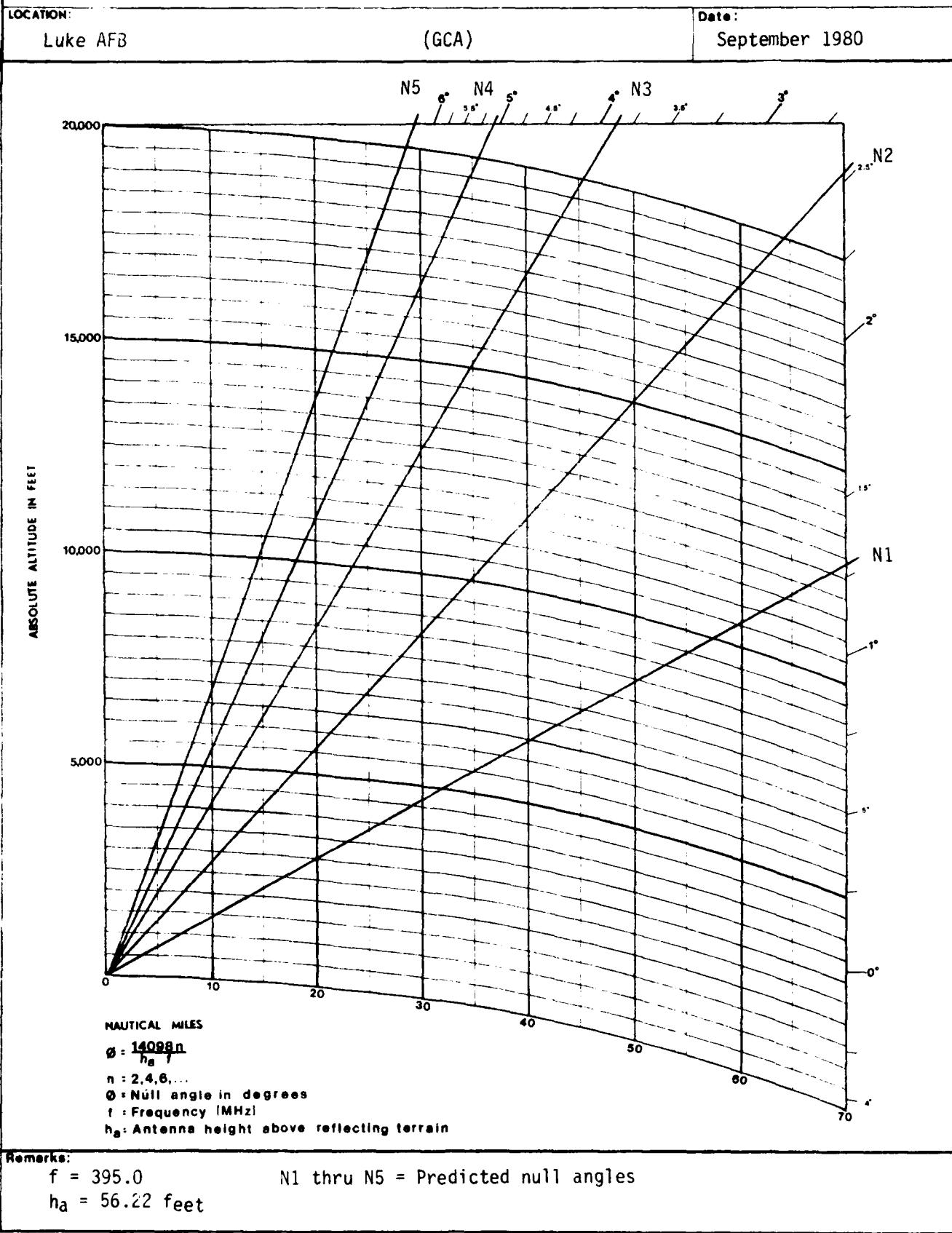
NULL ANGLE PREDICTIONS



NULL ANGLE PREDICTIONS

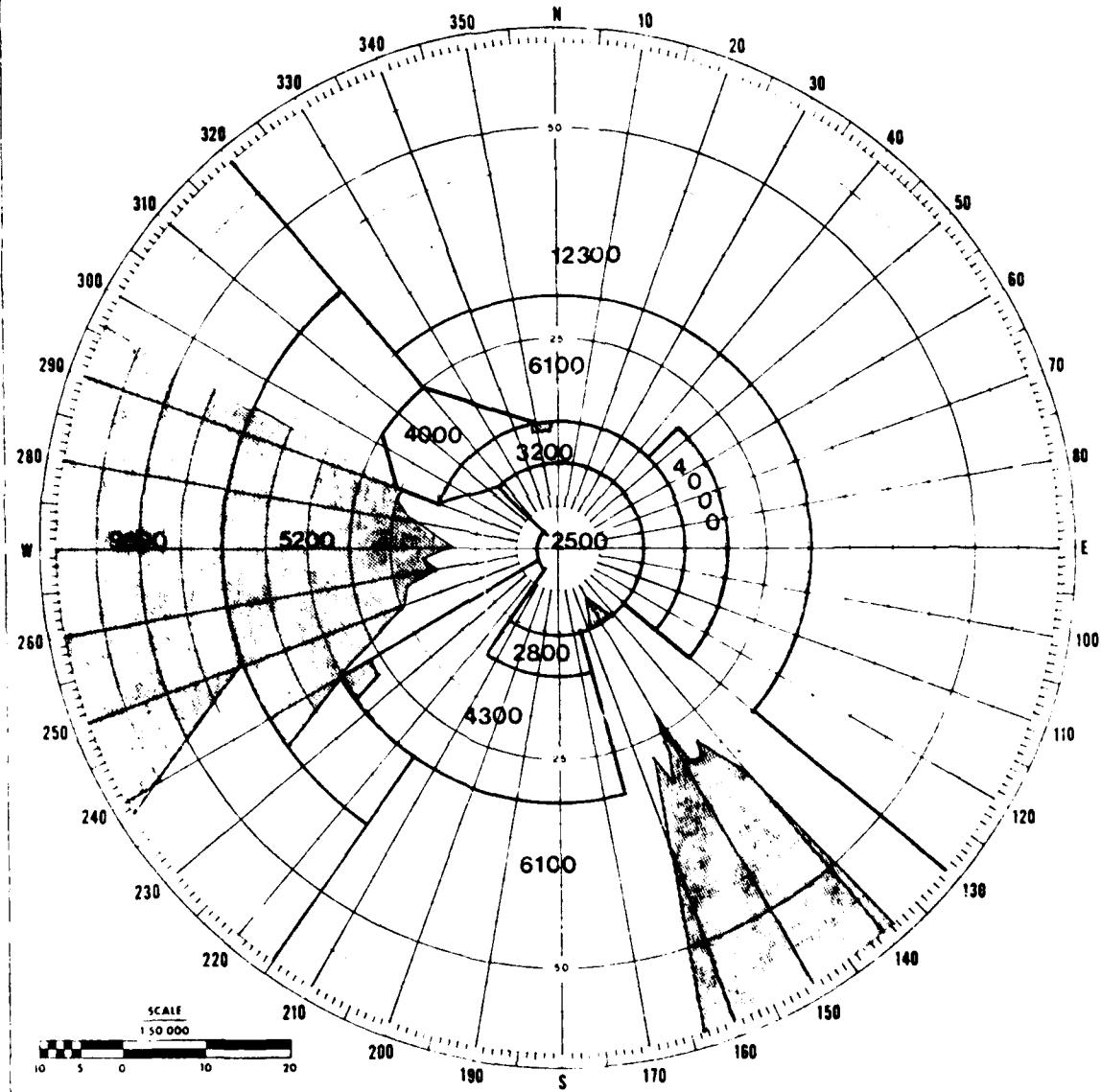


NULL ANGLE PREDICTIONS



RADIO LINE OF SIGHT RANGE

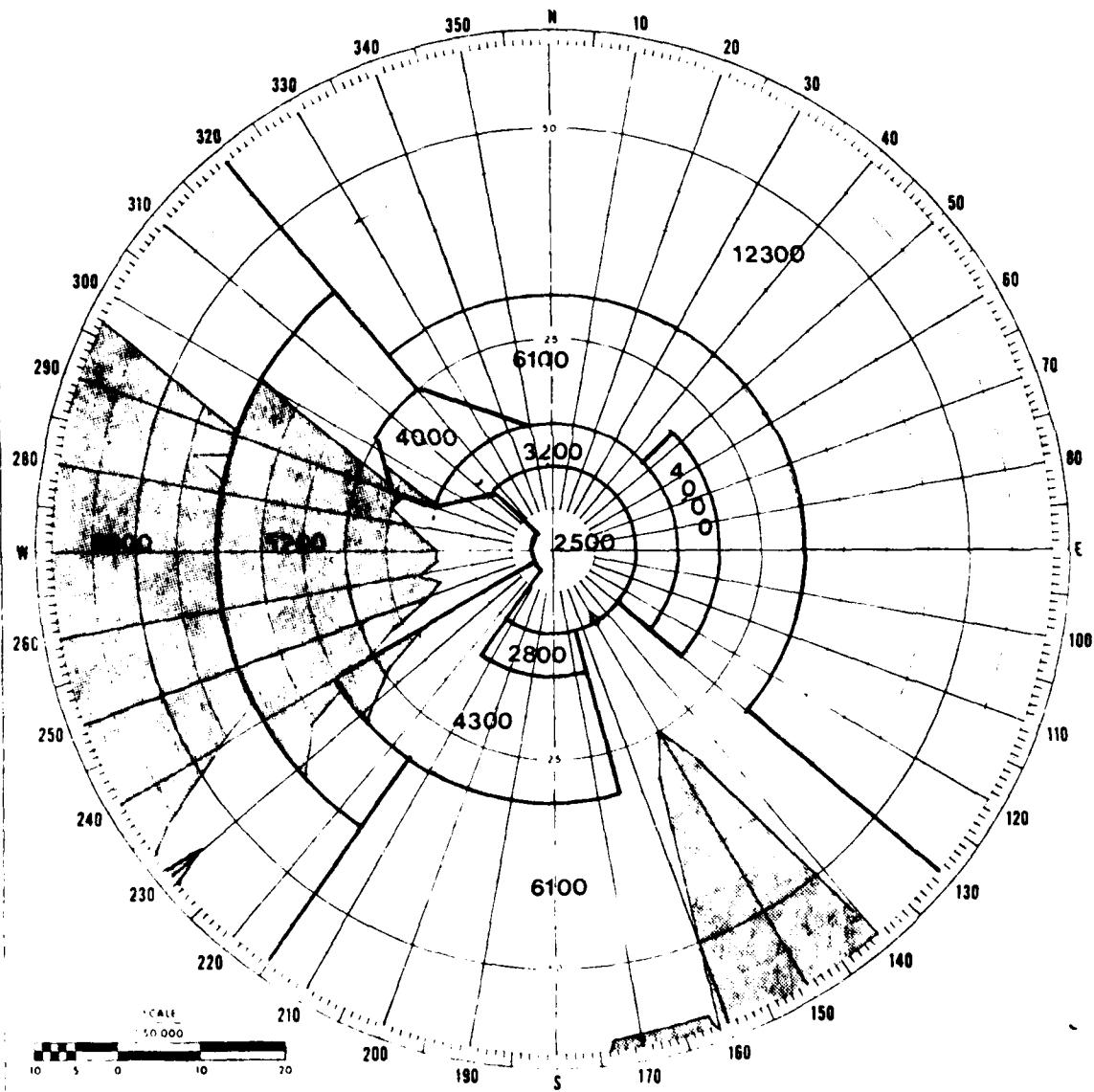
| | | |
|-----------------------------|----------------------------------|--------------------------------|
| LOCATION Luke AFB | FIELD ELEVATION 1080 feet MSL | TYPE COVERAGE Control Tower |
| LATITUDE 33° 32' 0" W | MAGNETIC VARIATION. 13° East | ALTITUDE: As shown |
| LONGITUDE 112° 22' 31" N | ORIENTED TO Magnetic North | Ant Height: 1206 feet MSL |



Shaded areas represent areas of coverage limitations due to RLOS screening.

RADIO LINE OF SIGHT RANGE

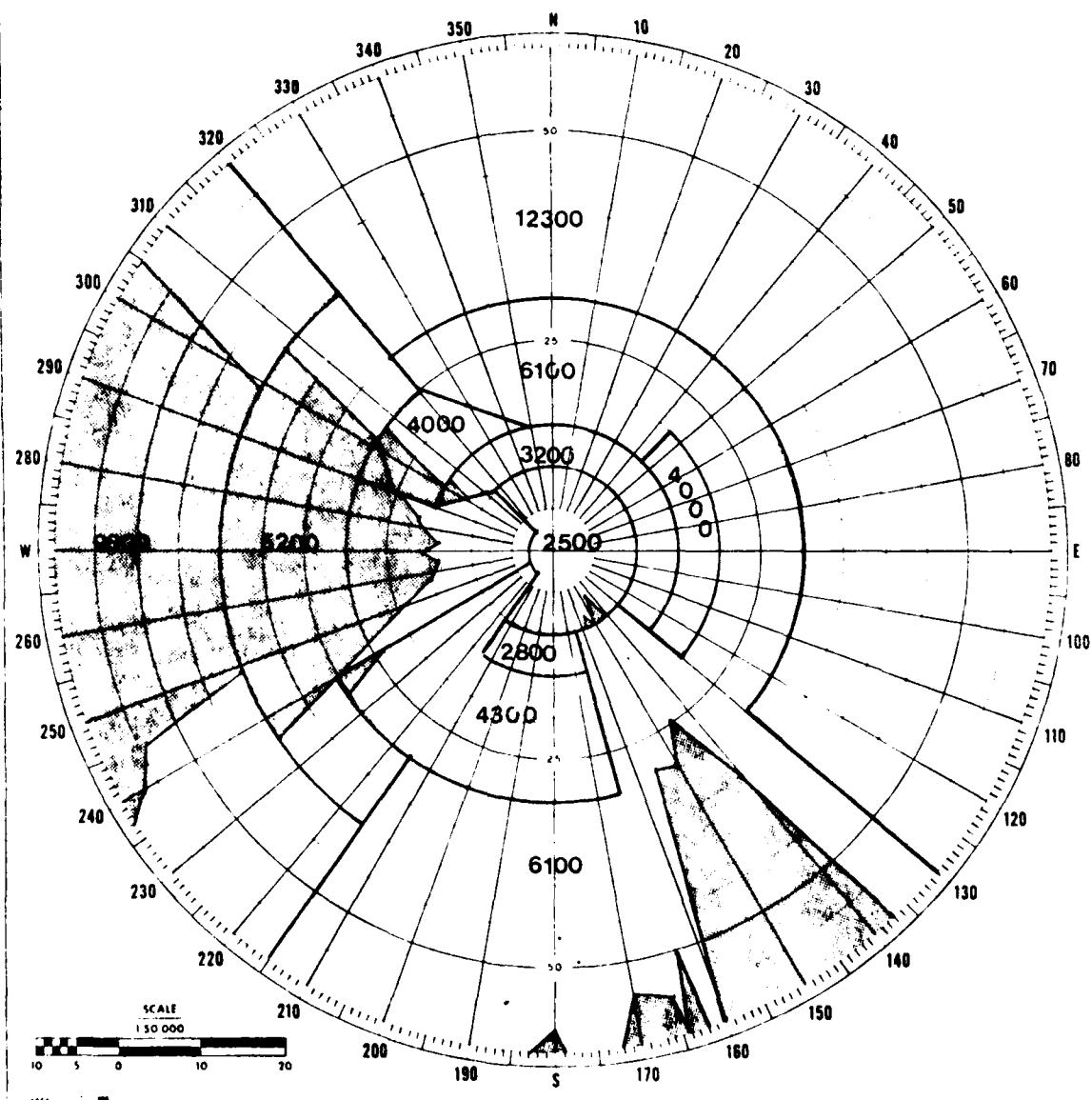
| | | |
|-----------------------------|----------------------------------|-----------------------------------|
| LOCATION Luke AFB | FIELD ELEVATION 1080 feet MSL | TYPE COVERAGE Transmitter Site |
| LATITUDE 33° 32' 47" W | MAGNETIC VARIATION 13° East | ALTITUDE: As shown |
| LONGITUDE 112° 22' 53" N | ORIENTED TO Magnetic North | Ant Height: 1128 feet MSL |



Shaded areas represent areas of coverage limitations due to RLOS screening.

RADIO LINE OF SIGHT RANGE

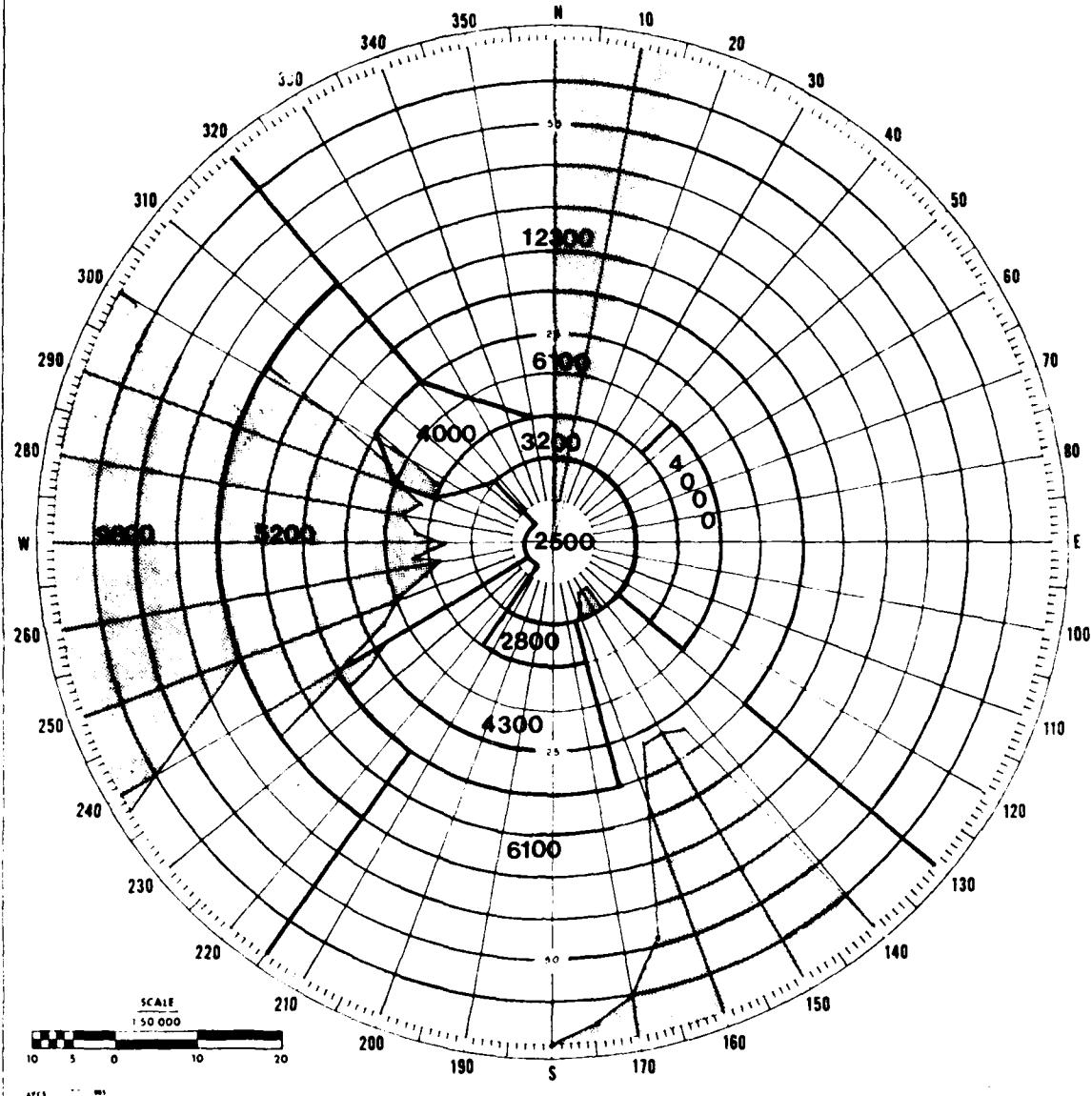
| | | |
|-----------------------------|----------------------------------|---------------------------------|
| LOCATION Luke AFB | FIELD ELEVATION 1080 feet MSL | TYPE COVERAGE: Receiver Site |
| LATITUDE: 33° 31' 25" W | MAGNETIC VARIATION: 13° East | ALTITUDE: As shown |
| LONGITUDE 112° 23' 12" N | ORIENTED TO: Magnetic North | Ant Height: 1146 feet MSL |



Shaded areas represent areas of coverage limitations due to RLOS screening.

RADIO LINE OF SIGHT RANGE

| | | |
|-----------------------------|----------------------------------|---------------------------|
| LOCATION Luke AFB | FIELD ELEVATION 1080 feet MSL | TYPE COVERAGE GCA |
| LATITUDE 33° 31' 30" N | MAGNETIC VARIATION. 13° East | ALTITUDE As shown |
| LONGITUDE 112° 22' 31" W | ORIENTED TO Magnetic North | Ant Height: 1136 feet MSL |



Shaded areas represent areas of coverage limitations due to RLOS screening.

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Transmitters: AN/GRT-21 and AN/GRT-22 (TO 31R2-2GRT-102)

| | |
|---------------------------------------|---|
| Percent of modulation, 0 dBm input: | : 90%+10% |
| Percent of modulation, -15 dBm input: | : 90%+10% |
| Percent of modulation, +10 dBm input: | : 90%+10% |
| Distortion: | : 10% at lower limiting : 15% at upper limiting |
| Frequency accuracy tolerance: | : +0.0005% with freq synthesizer |
| Power output: | : 10 watts minimum, low power : 50 watts minimum, high power |
| Reflected power: | : 2.5 watts maximum, low power : 12.5 watts maximum, high power |
| Transmission system VSWR: | : Normal operation at carrier power with VSWR not greater than 3 to 1 |
| Coupler loss | |
| CU-547: | : 2 dB maximum (TO 31R1-2GR-142) |
| Antenna VSWR | |
| AS-1097/GR: | : 2:1 maximum (TO 31R1-2GR-241) |
| AT-197/GR: | : 1.6:1 maximum (TO 31R1-2GR-161) |
| AS-1181/UR: | : 2:1 maximum (TO 31R1-2UR-31) |

B. Receivers: AN/GRR-23 and AN/GRR-24 (TO 31R2-2GRR-112)

| | |
|-------------------------------|--|
| Frequency accuracy tolerance: | : +0.0005% with freq synthesizer |
| Sensitivity: | : 3uv maximum |
| Signal to noise: | : 10 dB with a 3uv input |
| Squelch threshold: | : 3uv (TO 31R2-2GRR-116WC-1) |
| AGC characteristics: | : 3 dB maximum variation with signal of 6uv to 1v |
| Audio output: | : +20 dBm with older preamplifier module, +14 dBm with newer preamplifier module |
| Distortion: | : for frequencies 300, 1500, and 3000 Hz with a 1v input: 10 maximum with 30% modulation, 20 maximum with 90% modulation |
| Transmission system VSWR: | : no specification available |
| Coupler loss | |
| CU-547: | : 2 dB maximum (TO 31R1-2GR-142) |
| Antenna VSWR | |
| AS-1097/GR: | : 2:1 maximum (TO 31R1-2GR-241) |
| AT-197/GR: | : 1.6:1 maximum (TO 31R1-2GR-161) |
| AS-1181/UR: | : 2:1 maximum (TO 31R1-2UR-31) |

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Transceiver: AN/GRC-171 (TO 31R2-2GRC171-2)

| | |
|---------------------------------------|---|
| Percent of modulation, 0 dBm input: | 85% to 95% |
| Percent of modulation, -15 dBm input: | 85% to 95% |
| Percent of modulation, +10 dBm input: | 85% to 95% |
| Transmit audio distortion: | 10% maximum |
| Frequency accuracy tolerance: | + 0.0005% |
| Power output: | 16 watts minimum |
| Sensitivity: | 3 uV maximum |
| Signal plus noise to noise: | 10 dB minimum (notch tone method) with a 3 uV RF input |
| Squelch threshold: | 3 uV |
| AGC characteristics: | 3 dB maximum variation with RF input signal changing from 6 uV to 1 Volt |
| Audio Output: | +20 dBm (100 mw) |
| Receive Audio Distortion: | 10% maximum with a 1 Volt RF input modulated at 30%. 15% maximum when modulated at 90% |
| Antenna VSWR: | |
| AS-1097/GR (TO 31R1-2GR-241) | 2.00:1 maximum |
| AT-197/GR (TO 31R1-2GR-161) | 1.60:1 maximum |

B. Transceiver: AN/GRC-175 (TO 31R2-2GR-1042)

| | |
|---------------------------------------|---|
| Percent of modulation, 0 dBm input: | 90% minimum |
| Percent of modulation, +10 dBm input: | 100% maximum |
| Transmit audio distortion: | No Specification Available |
| Frequency accuracy tolerance: | + 0.001% |
| Power output: | 25 watts minimum |
| Sensitivity: | 3 uV maximum |
| Signal plus noise to noise: | 6 dB minimum with a 3 hard uV RF input |
| Squelch threshold: | 3 uV |
| AGC characteristics: | 3 dB maximum variation with RF input signal of 5 uV to 100 mV |
| Audio output: | +20 dBm (100 mw) |
| Receive audio distortion: | 7.5% maximum with a 1 Volt RF input modulated at 30%. 20% when modulated at 90% |
| Antenna VSWR: | |
| AS-1181/UR (TO 31R1-2UR-31) | 2.00:1 maximum |

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Communications Control Equipment: AN/GRA-81 and AN/GRA-83

1. Line, Speaker, Phone Amplifiers: AM-4571/G (TO 31R1-2G-102)

Gain: -20 dBm input at 1 kHz, output should not be less than +30 dBm (or 50 dBm minimum gain)
Noise level: -40 dBm maximum
Distortion: 5% maximum at rated output (2 watts; +33 dBm)

2. Microphone Amplifiers: AM-4568/G (TO 31R1-2G-112)

Gain: -64 dBm input at 1 kHz, output should not be less than +8 dBm (or 72 dB minimum gain)
Noise level: -40 dBm maximum
Distortion: 5% maximum at rated output (200 milliwatts; +23 dBm)

B. Communications Control Equipment: OJ-314

1. Microphone Amplifiers: 7A1A8

Gain: 18 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum with amplifier adjusted for compression

2. Speaker Amplifiers: 7A1A2

Gain: 40 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum

3. Headphone Amplifiers: 7A1A4A

Gain: 20 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum

4. Monitor Amplifiers: 7A1A4B

Gain: No specifications available
Noise level: -40 dBm maximum
Distortion: 5% maximum

5. Receiver Amplifiers: 2A1-2A2

Gain: 20 dBm minimum
Noise level: -40 dBm maximum
Distortion: 3% maximum

TITLE
EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Line, Speaker, Phone Amplifiers: AM-4571/G (TO 31R1-2G-102)

Gain: -20 dBm input at 1 kHz, output should not be less than +30 dBm (or 50 dB minimum gain)

Noise level: -40 dBm maximum

Distortion: 5% maximum at rated output (2 watts; +33 dBm)

B. Microphone Amplifiers: AM-4568/G (TO 31R1-2G-112)

Gain: -64 dBm input at 1 kHz, output should not be less than +8 dBm (or 72 dB minimum gain)

Noise level: -40 dBm maximum

Distortion: 5% maximum at rated output (200 milliwatts; +23 dBm)

REMARKS

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS
(*Multichannel*)

| | | | | | |
|--------------------------|---------|------------|---------|------------------------|---------|
| LOCATION Luke AFB | | (GCA) | | DATE September 1980 | |
| TRANSCIEVER NOMENCLATURE | | AN/GRC-171 | | | |
| SERIAL NUMBER | | 1138 | | | |
| FREQUENCY | MHZ | 225.0 | 312.0 | 395.0 | |
| MODULATION LEVEL | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | 81* | 86 | 86 | 90 | 86 |
| UPPER LIMITING | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | 81* | 86 | 86 | 90 | 86 |
| LOWER LIMITING | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | 81* | 86 | 86 | 90 | 86 |
| TRANSMIT DISTORTION | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | 5.2 | | 5.4 | | 5.2 |
| FREQUENCY ACCURACY | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | .00003 | | .00004 | | .00004 |
| RF POWER OUT FORWARD | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | WATTS | 27 | 24 | 24 | 23 |
| SENSITIVITY | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | μV | 2.2 | 2.1 | 2.1 | 2.3 |
| SIGNAL TO NOISE | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | dB | 15 | 13.6 | 13.6 | 14.5 |
| ACQUISITION THRESHOLD | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | μV | 3 | 3 | 3 | 4* |
| AGC | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | dB | 0.6 | 1.0 | 1.0 | 0.8 |
| AUDIO OUT | Equip | Line dBm | -2 | 20 | 20 |
| | | | -16 | 0 | 0 |
| RECEIVE DISTORTION | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | ~ | 6.4 | 6.8 | 6.8 | 9.0 |
| ANTENNA VSWR | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | | 1.5:1 | 1.5:1 | 1.5:1 | 1.5:1 |

REMARKS

* Out of tolerance

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS
(Multichannel)

| | | | | | | |
|----------------------------|--|------------|----------|----------------|----------|-----|
| LOCATION | | (GCA) | | DATE | | |
| Luke AFB | | | | September 1980 | | |
| TRANSCIEVER NOMENCLATURE | | AN/GRC-175 | | | | |
| SERIAL NUMBER | | 66184 | | | | |
| FREQUENCY MHz | | 116.0 | | 124.0 | | |
| MODULATION LEVEL | | INITIAL | ADJUSTED | INITIAL | ADJUSTED | N/A |
| MODULATION LEVEL | | 60* | | 60* | | |
| UPPER LIMITING | | N/A | | N/A | | |
| LOWER LIMITING | | 68* | | 68* | | |
| TRANSMIT DISTORTION | | 4.8 | | 9.4 | | |
| FREQUENCY ACCURACY | | .0001 | | .0001 | | |
| RF POWER OUT FORWARD WATTS | | 36 | | 41 | | |
| SENSITIVITY µV | | 3 | | 3 | | |
| SIGNAL TO NOISE dB | | 7 | | 10 | | |
| SQUELCH THRESHOLD µV | | 3 | | 3 | | |
| AGC dB | | 1.0 | | 0.4 | | |
| ACQ OUT Line dBm | | 0.8 | | 1.8 | | |
| RECEIVE DISTORTION | | 10 | | 13 | | |
| ANTENNA VSWR | | 1.17:1 | | 1.17:1 | | |
| REMARKS | | | | | | |

* Out of tolerance - referred to maintenance

| AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS (Multi channel) | | | | | | | |
|---|-------|----------------|----------------|------------------------|----------------|--|--|
| LOCATION Luke AFB (Control Tower) | | | | DATE September 1980 | | | |
| TRANSCIEVER NOMENCLATURE | | AN/GRC-171 | | | | | |
| SERIAL NUMBER | | 547 | | | | | |
| FREQUENCY | MHZ | 225.0 | | 312.0 | | | |
| MODULATION LEVEL | | INITIAL 99* | ADJUSTED 90 | INITIAL 90 | ADJUSTED 90 | | |
| UPPER LIMITING | | 99* | 90 | 90 | 90 | | |
| LOWER LIMITING | | 99* | 90 | 90 | 90 | | |
| TRANSMIT DISTORTION | | 8.0 | 4.2 | 3.8 | 4.2 | | |
| FREQUENCY ACCURACY | | .00002 | | .00002 | | | |
| RF POWER OUT FORWARD | WATTS | 18 | | 16 | | | |
| SENSITIVITY | μV | 1.6 | | 2.2 | | | |
| SIGNAL TO NOISE | dB | 15 | | 12 | | | |
| THRESHOLD | μV | 5* | 3 | 3 | 3 | | |
| AGC | dB | 0.6 | | 1.0 | | | |
| ANT C OUT | Line | dBm | -10 * | 0.0 | 0.0 | | |
| RECEIVE DISTORTION | | | 7 | 8 | 8 | | |
| ANTENNA VSWR | | | ** | ** | ** | | |

* Out of tolerance

** Not measured

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS
(*Multichannel*)

| | | | | | | | |
|---|-------|----------------|---------------|------------------------|----------|--|--|
| LOCATION Luke AFB (Control Tower) | | | | DATE September 1980 | | | |
| TRANSCOMM NOMENCLATURE | | AN/GRC-175 | | | | | |
| SERIAL NUMBER | | 585 | | | | | |
| FREQUENCY | MHZ | 116.0 | 124.0 | | | | |
| MODULATION LEVEL | | INITIAL 60* | ADJUSTED * | INITIAL 60* | ADJUSTED | | |
| UPPER LIMITING | | N/A | | N/A | | | |
| LOWER LIMITING | | 100* | | 100* | | | |
| TRANSMIT DISTORTION | | 7.3 | | 14 | | | |
| FREQUENCY ACCURACY | | .00001 | | .00001 | | | |
| RF POWER OUT FORWARD | WATTS | 25 | | 34 | | | |
| SENSITIVITY | μV | 3.0 | | 2.5 | | | |
| ANAL TO NOISE | dB | 10 | | 14.5 | | | |
| DETECTION THRESHOLD | μV | 6 | | 3 | | | |
| AGC | dB | 0.8 | | 0.2 | | | |
| AUDIO OUT Line | dBm | -6.0 | | -6.0 | | | |
| RECEIVE DISTORTION | | 10 | | 8 | | | |
| ANTENNA VSWR | | ** | | ** | | | |

* Out of tolerance - referred to maintenance

** Not measured

| AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS | | | | DATE September 1960 | |
|--|-----------|----------|-----------|------------------------|-------------|
| LOCATION Luke AFB | | | | | |
| FREQUENCY MHz | 126.2 | | 134.1 | | 289.6 |
| 1. TRANSMITTER NOMENCLATURE | AN/GRT-21 | | AN/GRT-21 | | AN/GRT-22 |
| 2. SERIAL NUMBER | 531 | | 329 | | 3521 |
| 3. MODULATION LEVEL | INITIAL | ADJUSTED | INITIAL | ADJUSTED | INITIAL |
| | 79* | 88 | 95 | | 86 |
| 4. LOWER LIMITING | 81 | 88 | 90 | | 83 |
| 5. UPPER LIMITING | 77* | 86 | 95 | | 88 |
| 6. DISTORTION | 4.6 | | 9.2 | | 3.5 |
| 7. FREQUENCY ACCURACY | .00007 | | .00002 | | .00006 |
| RF POWER OUT 8. FORWARD Watts | 8* | 10 | 6.8* | 10 | 7* 10 |
| 9. COUPLER VSWR | N/A | | N/A | | 1.7:1 1.3:1 |
| 10. COUPLER LOSS dB | N/A | | N/A | | 2.4* 1.8 |
| 11. ANTENNA VSWR | 1.66:1 | | 1.1:1 | | 2.4:1* |
| 12. RECEIVER NOMENCLATURE | AN/GRR-23 | | AN/GRR-23 | | AN/GRR-24 |
| 13. SERIAL NUMBER | 66-353 | | 6270 | | 4913 |
| 14. FREQUENCY ACCURACY | .0011 | | .00005 | | .00016 |
| 15. SENSITIVITY dBV | 1.8 | | 1.3 | | 4.0* 2.3 |
| 16. SIGNAL TO NOISE dB | 21.0 | | 13.5 | | 7.5* 15.0 |
| 17. GLEICH THRESHOLD dBV | 1.8* | 3.0 | 2.0* | 3.0 | 3.0 |
| 18. AGC | 1.0 | | 1.0 | | 0.5 |
| 19. AUDIO OUT Equip Line dBm | -2.0* | 20 | 5.5* | 19.5 | 20.0 |
| | -0.6 | 0.0 | -1.5 | 0.0 | -1.0 |
| 20. DISTORTION | 11.5* | | 1.2 | | 3.4 |
| 21. COUPLER VSWR | N/A | | N/A | | 1.06:1 |
| 22. COUPLER LOSS dB | N/A | | N/A | | 1.6 |
| 23. ANTENNA VSWR | 1.3:1 | | 1.4:1 | | 1.04:1 |
| REMARKS * Out of tolerance | | | | | |

| AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS | | | | DATE September 1980 | |
|--|-----|------------|--|------------------------|-------------------|
| LOCATION Luke AFB | | | | | |
| FREQUENCY | MHz | 349.7** | 389.8 | 395.0 | |
| 1. TRANSMITTER NOMENCLATURE | | AN/GRT-22 | | AN/GRT-22 | |
| 2. SERIAL NUMBER | | 14584 | | 14841 | |
| | | INITIAL | ADJUSTED | INITIAL | ADJUSTED |
| 3. MODULATION LEVEL | | 100* | 90 | 88 | 86 |
| 4. LOWER LIMITING | | 97 | 81 | 83 | 81 |
| 5. UPPER LIMITING | | 100* | 92 | 90 | 86 |
| 6. DISTORTION | | 14.5* | 12.0 | 3.8 | 3.9 |
| 7. FREQUENCY ACCURACY | | .00009 | | .00002 | .000002 |
| 8. RF POWER OUT FORWARD | | Watts | 8* | 10 | 8.2* |
| 9. COUPLER VSWR | | | 1.08:1 | 1.2:1 | 1.27:1 |
| 10. COUPLER LOSS | | dB | 1.8 | 1.5 | 1.7 |
| 11. ANTENNA VSWR | | | 1.1:1 | 1.6:1 | 1.2:1 |
| 12. RECEIVER NOMENCLATURE | | AN/GRR-24 | | AN/GRR-24 | |
| 13. SERIAL NUMBER | | 4338 | | 3243 | |
| 14. FREQUENCY ACCURACY | | .00007 | | .00005 | .00005 |
| 15. SENSITIVITY | | UV | 30* | 1 | 1.2 |
| 16. SIGNAL TO NOISE | | dB | 3.5* | 13 | 17.2 |
| 17. SQUELCH THRESHOLD | | UV | 3.0 | 3.0 | 3.0 |
| 18. AGC | | | 0.5 | 0.5 | 0.7 |
| 19. AUDIO OUT | | Equip Line | 21 -3.5* | 21 0.0 | 16* -0.5 19.8 0.0 |
| 20. DISTORTION | | | 2.5 | 3.2 | 2.0 |
| 21. COUPLER VSWR | | | 4.4 1* | 4.4:1* | 3.54:1* 1.04:1 |
| 22. COUPLER LOSS | | dB | 5.7* | 5.0* | 5.0* 4.0* |
| 23. ANTENNA VSWR | | | 1.08:1 | 1.04:1 | 1.02:1 |
| REMARKS | | | | | |
| * Out of tolerance | | | ** Metering circuit switch affects modulation. | | |

RF TRANSMISSION SYSTEMS ANALYSIS

| LOCATION Luke AFB (Transmitter Site) | | | | | DATE September 1980 | | | |
|--|---------|---------|--------------|------------|------------------------|--------|---------------------------|----------------------|
| ANTENNA | | | | | COUPLER | | | |
| NO. | TYPE | VSWR | CABLE LENGTH | FREQ (MHz) | SERIAL NO. | CAVITY | LOSS (dB) INIT. / ADJ. | VSWR INIT. / ADJ. |
| 1 | AS-1181 | 1.66:1 | | 126.2 | | | | |
| 2 | AS-1181 | 1.30:1 | | 121.5 | | | | |
| 3 | AS-1097 | 1.20:1 | 42 feet | 395.0 | | 1 | 1.7 | 1.27:1 |
| | | 2.40.1* | | 289.6 | | 2 | 2.4* | 1.8 1.70:1 1.30:1 |
| | | 1.70:1 | | 243.0 | | 3 | 2.1* | 1.8 1.70:1 1.02:1 |
| | | 1.80:1 | | 335.8 | | 4 | 1.8 | 1.6 1.70:1 1.10:1 |
| 4 | AS-1097 | 1.60:1 | | Spare | | | | |
| 5 | AS-1097 | 1.50:1 | | Spare | | 1 | | |
| | | 1.80:1 | | 337.7 | | 2 | 1.5 | 1.15:1 |
| | | 1.50:1 | | 242.3 | | 3 | 4.8* | 1.6 4.00:1* 1.02:1 |
| | | 1.30:1 | | 375.2 | | 4 | 1.5 | 1.13:1 |
| 6 | AS-1097 | 1.70:1 | | 296.1 | | 1 | 1.9 | 1.5 1.60:1 1.06:1 |
| | | 1.20:1 | | 325.9 | | 2 | 1.5 | 1.02:1 |
| | | 1.30:1 | | 266.4 | | 3 | 1.6 | 1.02:1 |
| | | 1.10:1 | | 372.2 | | 4 | 1.4 | 1.06:1 |
| 7 | AS-1097 | 1.30:1 | | Spare | | | | |
| 8 | AT-197 | 1.10:1 | | Spare | | | | |
| 10 | AS-1097 | 1.10:1 | | 349.7 | | 1 | 1.8 | 1.08:1 |
| | | 1.60:1 | | 389.8 | | 2 | 1.5 | 1.20:1 |
| | | 1.10:1 | | 301.5 | | 3 | 2.9* | 1.5 1.80:1 |
| | | 1.30:1 | | 316.9 | | 4 | 1.4 | 1.70:1 |

REMARKS

* Out of tolerance

RF TRANSMISSION SYSTEMS ANALYSIS

REMARKS

* Out of tolerance

RF TRANSMISSION SYSTEMS ANALYSIS

| LOCATION Luke AFB ANTENNA | | | | | (Receiver Site) | | | | DATE September 1980 | |
|---------------------------------|--------|--------|-----------------|---------------|-----------------|--------|--------------------|-------------------|------------------------|--------|
| NO. | TYPE | VSWR | CABLE LENGTH | FREQ (MHz) | SERIAL NO. | CAVITY | COUPLER | | VSWR | |
| | | | | | | | LOSS (dB) INIT. | LOSS (dB) ADJ. | | |
| B-1 | AT-197 | 1.02:1 | 110 feet | 395.0 | 429 | 1 | 4.0* | 1.9 | 3.54:1* | 1.04:1 |
| | | 1.04:1 | | 289.6 | | 2 | 1.6 | | 1.06:1 | |
| | | 1.04:1 | | 256.9 | | 3 | 1.8 | | 1.22:1 | |
| | | 1.04:1 | | 243.0 | | 4 | 7.3* | 4.0* | 6.7:1* | |
| B-2 | AT-197 | 1.13:1 | | 335.8 | 591 | 1 | 2.8* | 2.4* | 1.60:1 | |
| | | 1.08:1 | | 349.7 | | 2 | 5.7* | 5.0* | 4.40:1* | |
| | | 1.04:1 | | 389.8 | | 3 | 5.5* | 5.0* | 4.40:1* | |
| | | 1.40:1 | | 301.5 | | 4 | 2.5* | 1.6 | 2.70:1* | 1.20:1 |
| B-3 | AT-197 | | | Spare | 1329 | 1 | | | | |
| | | 1.04:1 | | 337.7 | | 2 | 1.4 | | 1.30:1 | |
| | | 1.08:1 | | 242.3 | | 3 | 3.3* | 1.3 | 3.00:1* | 1.08:1 |
| | | 1.35:1 | | 375.2 | | 4 | 1.4 | | 1.20:1 | |
| B-4 | AT-197 | 1.13:1 | | 296.1 | 623 | 1 | 1.5 | | 1.06:1 | |
| | | 1.02:1 | | 325.9 | | 2 | 3.6* | 3.4* | 2.90:1* | |
| | | 1.02:1 | | 266.4 | | 3 | 3.2* | 3.2* | 2.27:1* | |
| | | 1.02:1 | | 372.2 | | 4 | 10.0* | 9.0* | 10.7:1* | |
| B-5 | AT-197 | 1.06:1 | | 257.2 | 1427 | 1 | 1.7 | | 2.70:1* | |
| | | 1.06:1 | | 349.0 | | 2 | 1.7 | | 1.06:1 | |
| | | 1.50:1 | | 388.9 | | 3 | 4.4* | 1.9 | 2.90:1* | 1.04:1 |
| | | 1.10:1 | | 311.2 | | 4 | 1.5 | | 1.13:1 | |

REMARKS

* Out of tolerance

RF TRANSMISSION SYSTEMS ANALYSIS

LOCATION

(Receiver Site)

DATE

REMARKS

* Out of tolerance

** Moved frequency from port 4 to port 2 to reduce insertion loss.

RF TRANSMISSION SYSTEMS ANALYSIS

LOCATION Luke AFB

(GCA)

DATE

ANTENNA

COUPLER

REMARKS

AMPLIFIER DATA

| | | | | | | | |
|---|-----------------------|-------|---------|--------|----------------|--|--|
| LOCATION | Luke AFB (GCA) | | | DATE | September 1980 | | |
| Audio Frequency Amplifier AM-4568/G (Microphone Amplifier) | | | | | | | |
| MEASUREMENTS | Serial Number | 605 | 647 | 460 | | | |
| | Position | ASR-1 | ASR-3 | ASR-2 | | | |
| | Input Level dBm | -35.0 | -35.0 | -35.0 | | | |
| | Output Level dBm | 19.4 | 19.4 | 19.8 | | | |
| | Distortion % | 3.0 | 2.5 | 2.9 | | | |
| | Noise Level dBm | -47.5 | -48.0 | -58.0 | | | |
| | Input at Limiting dBm | -39.0 | -39.0 | -39.0 | | | |
| Output at Limiting dBm | 19.2 | 19.1 | 19.8 | | | | |
| GAIN | Input Level dBm | -64.0 | -64.0 | -64.0 | | | |
| | Output Level dBm | 21.2 | 20.4 | 21.6 | | | |
| | Distortion % | 8.6 * | 9.2 * | 15.0 * | | | |
| | Noise Level dBm | -42.0 | -28.0 * | -50.0 | | | |
| REMARKS | | | | | | | |
| * Out of tolerance | | | | | | | |

AMPLIFIER DATA

Luke AFB

(GCA)

September 1980

Audio Frequency Amplifier AM-4571/G

| | Frequency | MHz | 349.0 | 372.9 | 291.1 | 368.9 | 134.1 | 120.5 |
|--|----------------|-----|---------------|---------------|---------------|---------------|----------------|----------------|
| M E A S U R E M E N T S | Input Level | dBm | -2.4 | -2.6 | -2.4 | -2.6 | -2.2 | -2.5 |
| S Y S T E M G A I N | Output Level | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| | Distortion | % | 5.0 | 5.0 | 4.9 | 4.8 | 5.0 | 4.5 |
| | Noise Level ** | dBm | -6.0 -60.0 | -6.5 -60.0 | -5.0 -57.5 | -3.0 -53.4 | -13.2 -53.0 | -10.0 -45.0 |
| | Input Level | dBm | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 |
| | Output Level | dBm | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | Distortion | % | 4.8 | 4.7 | 4.6 | 4.7 | 4.7 | 4.5 |
| | Noise Level | dBm | -7.6* | -7.0* | -7.0* | -4.8* | -14.3* | -11.5* |

** High noise levels caused by a defective power supply. After the power supply was replaced, noise levels were measured through the amplifier alone.

Audio Frequency Amplifier AM-4571/G

| | Frequency | MHz | 257.2 | 243.0 | 349.7 | 301.5 | 389.8 | 111.5 |
|--|--------------|-----|-------|-------|--------|-------|-------|-------|
| M E A S U R E M E N T S | Input Level | dBm | -2.0 | -5.6 | -2.4 | -2.5 | -2.4 | -5.5 |
| S Y S T E M G A I N | Output Level | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| | Distortion | % | 6.8* | 5.0 | 4.1 | 5.0 | 3.2 | 4.8 |
| | Noise Level | dBm | -48.6 | -58.5 | -49.0 | -44.0 | -57.0 | -53.0 |
| | Input Level | dBm | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 |
| | Output Level | dBm | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | Distortion | % | 7.0* | 4.7 | 4.3 | 5.0 | 2.5 | 5.0 |
| | Noise Level | dBm | -41.5 | -43.0 | -38.0* | -40.0 | -41.4 | -41.5 |

* Out of tolerance

***Replaced with spare

| AMPLIFIER DATA | | | | | | | | |
|----------------|--|--|--|-------|--|----------------|--|--|
| TEST SITE | | | | TEST | | DATE | | |
| Luke AFB | | | | (GCA) | | September 1980 | | |

Audio Frequency Amplifier AM-4571/G

| M E A S U R E M E N T S | S Y S T E M G A I N | | ASR-1 Phone | ASR-1 Speaker | ASR Phone | ASR-3 Speaker | ASR-3 Phone | ASR-2 Phone |
|--|--|--------------|----------------|------------------|--------------|------------------|----------------|----------------|
| | | Input Level | dBm | -34.6 | -34.6 | -34.6 | -34.6 | -34.6 |
| | | Output Level | dBm | -5.0 | -5.0 | -5.0 | -5.0 | -5.0 |
| | | Distortion | % | 2.8 | 3.8 | 3.1 | 4.0 | 3.0 |
| | | Noise Leve. | dBm | -48.0 | -47.5 | -49.0 | -40.5 | -46.0 |
| | | | | | | | | |
| | | Input Level | dBm | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 |
| | | Output Level | dBm | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | | Distortion | % | 4.0 | 4.4 | 4.5 | 5.0 | 5.0 |
| | | Noise Level | dBm | -38.0* | -35.0* | -36.0* | -36.0* | -33.0* |

Audio Frequency Amplifier AM-4571/G

| M E A S U R E M E N T S | S Y S T E M G A I N | | ASR-2 Speaker | ASR-2 Phone | | | | |
|--|--|--------------|------------------|----------------|--------|--|--|--|
| | | Input Level | dBm | -34.6 | -34.6 | | | |
| | | Output Level | dBm | -5.0 | -5.0 | | | |
| | | Distortion | % | 2.8 | 2.9 | | | |
| | | Noise Level | dBm | -47.0 | -44.5 | | | |
| | | | | | | | | |
| | | Input Level | dBm | -20.0 | -20.0 | | | |
| | | Output Level | dBm | 30.0 | 30.0 | | | |
| | | Distortion | % | 6.0* | 4.1 | | | |
| | | Noise Level | dBm | -38.0* | -33.0* | | | |

* Out of tolerance

AMPLIFIER DATA

LOCATION

Luke AFB

DATE

(Control Tower)

September 1980

Audio Frequency Amplifier AM-4571/G

| | | Position | Pos 1 Spkr 3 | Pos 1 Spkr 2 | Pos 1 Spkr 1 | Pos 1 Phone 1 | Spare Phone 1 | Spare Phone 1 |
|--|---|---------------------|-----------------|-----------------|-----------------|------------------|------------------|------------------|
| M E A S U R E M E N T S I N | S | Input Level dBm | -49.5 | -49.5 | -33.6 | -31.0 | | -31.0 |
| | Y | Output Level dBm | 0 | 0 | 0 | 0 | | 0 |
| | S | Distortion % | 1.2 | 0.8 | 0.5 | 3.0 | | 0.5 |
| | T | Noise Level dBm | -50.0 | -50.5 | -53.0 | -52.0 | | -60.0 |
| | A | Input Level dBm | -20 | -20 | -20 | -20 | -20 | -20 |
| | G | Output Level dBm | 30 | 30 | 30 | 30 | 28.5* | 30 |
| F R M E N T S I N | I | Distortion % | 2.4 | 2.2 | 4.6 | 8.0* | 11.5* | 5.3 |
| | N | Noise Level dBm | -48.0 | -49.0 | -47.0 | -49.0 | -32.5* | -52.0 |
| | | | | | | | | |

Audio Frequency Amplifier AM-4571/G

| | | | | | | | | |
|--|---|---------------------|--|--|--|--|--|--|
| | | | | | | | | |
| M E A S U R E M E N T S I N | S | Input Level dBm | | | | | | |
| | Y | Output Level dBm | | | | | | |
| | S | Distortion % | | | | | | |
| | T | Noise Level dBm | | | | | | |
| | A | Input Level dBm | | | | | | |
| | G | Output Level dBm | | | | | | |
| F R M E N T S I N | I | Distortion % | | | | | | |
| | N | Noise Level dBm | | | | | | |
| | | | | | | | | |

*Out of tolerance

** Replaced with spare.

TITLE

AMPLIFIER DATA

LOCATION

Luke AFB

(Control Tower)

September 1980

Audio Frequency Amplifier AM-4568/G
(Microphone Amplifier)

| | | | | | | | | |
|--|----------------------------|------------------------|-------|-------|-------|--|--|--|
| M E A S U R E M E N T S | S Y S T E M | Serial Number | 6 | 9 | 7 | | | |
| | | Position | 1 | 2 | 3 | | | |
| | | Input Level dBm | -35 | -35 | -35 | | | |
| | | Output Level dBm | 19.2 | 20.0 | 19.4 | | | |
| | | Distortion % | 3.0 | 3.0 | 2.9 | | | |
| | | Noise Level dBm | -50.0 | -75.0 | -72.2 | | | |
| | | Input at Limiting dBm | -39 | -39 | -39 | | | |
| | | Output at Limiting dBm | 19.0 | 19.8 | 19.2 | | | |
| G A I N | | Input Level dBm | -64 | -64 | -64 | | | |
| | | Output Level dBm | 22 | 21 | 22 | | | |
| | | Distortion % | 5 | 5 | 5 | | | |
| | | Noise Level dBm | -7 * | -40 | -21 * | | | |

REMARKS

* Out of tolerance

| AMPLIFIER DATA | | | |
|----------------|--|-----------------|--|
| LOCATION | | DATE | |
| Luke AFB | | (Control Tower) | |
| | | September 1980 | |

Audio Frequency Amplifier AM-4571/G

| MEASUREMENTS | SYNTH | Frequency | MHz | 259.6** | 259.6 | 121.5** | 121.5 | 243.0** | 243.0** |
|--------------|-------|--------------|-----|---------|-------|---------|-------|---------|---------|
| | | Input Level | dBm | -2.4 | -2.4 | -6.0 | -6.0 | -6.0 | -6.0 |
| | | Output Level | dBm | | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| | | Distortion | % | | 4.6 | 7.3* | 1.2 | 6.6* | 5.8* |
| | | Noise Level | dBm | | -46.0 | -58.5 | -53.0 | -60.0 | -58.0 |
| | GAIN | Input Level | dBm | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 |
| | | Output Level | dBm | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | | Distortion | % | 11.0* | -4.8 | 6.8* | 1.8 | 6.4* | 5.2* |
| | | Noise Level | dBm | | -44.0 | -48.0 | -48.0 | -51.0 | -50.0 |

Audio Frequency Amplifier AM-4571/G

| MEASUREMENTS | SYNTH | Frequency | MHz | 243.0 | 289.6 | 126.2** | 126.2 | 333.0 | 363.0 |
|--------------|-------|--------------|-----|-------|--------|---------|-------|-------|-------|
| | | Input Level | dBm | -6.0 | -3.0 | -3.2 | -3.2 | -2.8 | -2.6 |
| | | Output Level | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| | | Distortion | % | 2.2 | 4.8 | 6.4* | 4.4 | 4.2 | 4.2 |
| | | Noise Level | dBm | -57.5 | -31.0* | -58.0 | -59.0 | -56.5 | -59.0 |
| | GAIN | Input Level | dBm | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 | -20.0 |
| | | Output Level | dBm | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | | Distortion | % | 2.3 | 4.6 | 6.4* | 4.5 | 4.1 | 4.4 |
| | | Noise Level | dBm | -50.0 | -30.0* | -51.4 | -56.0 | -48.5 | -47.5 |

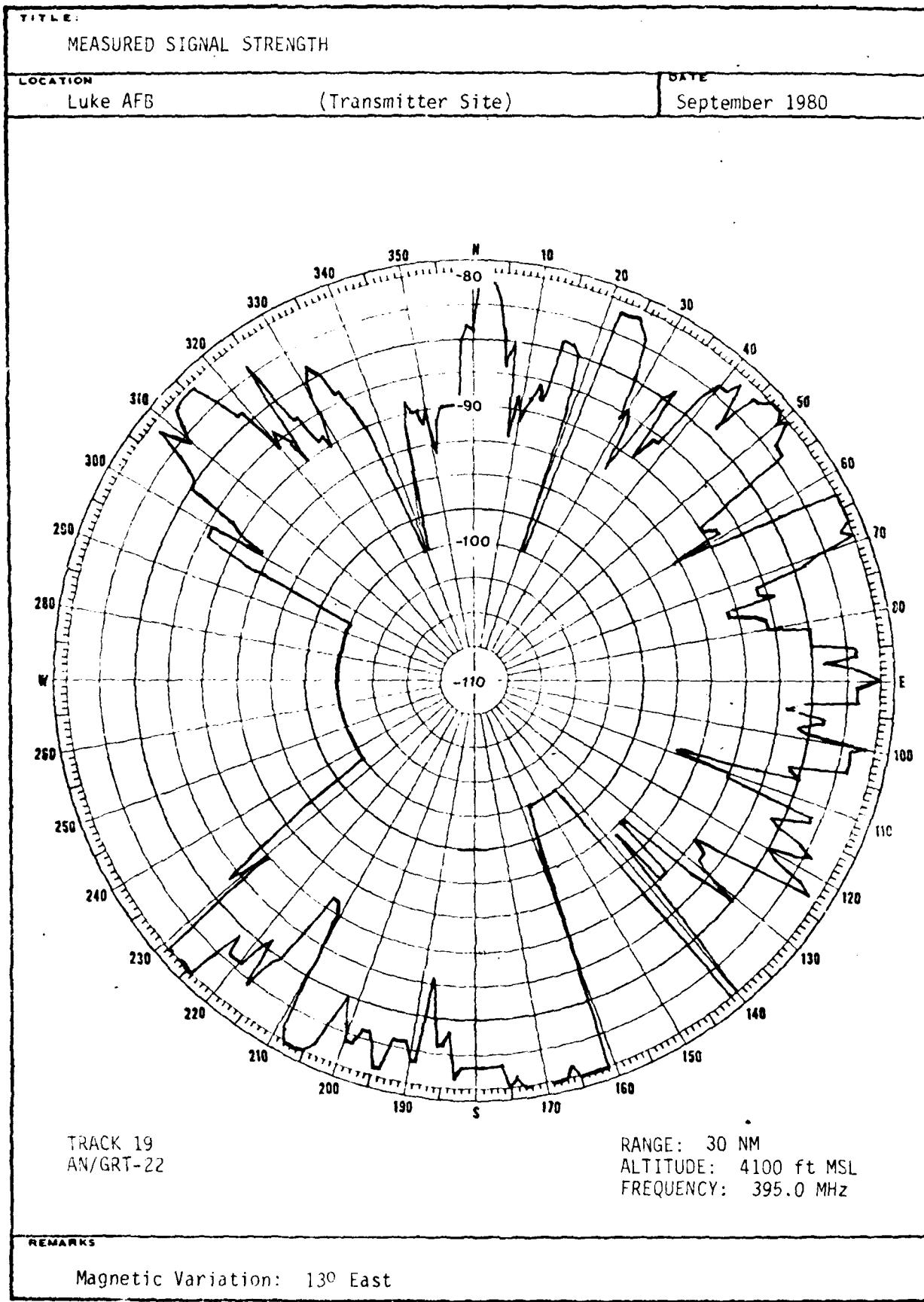
**Replaced

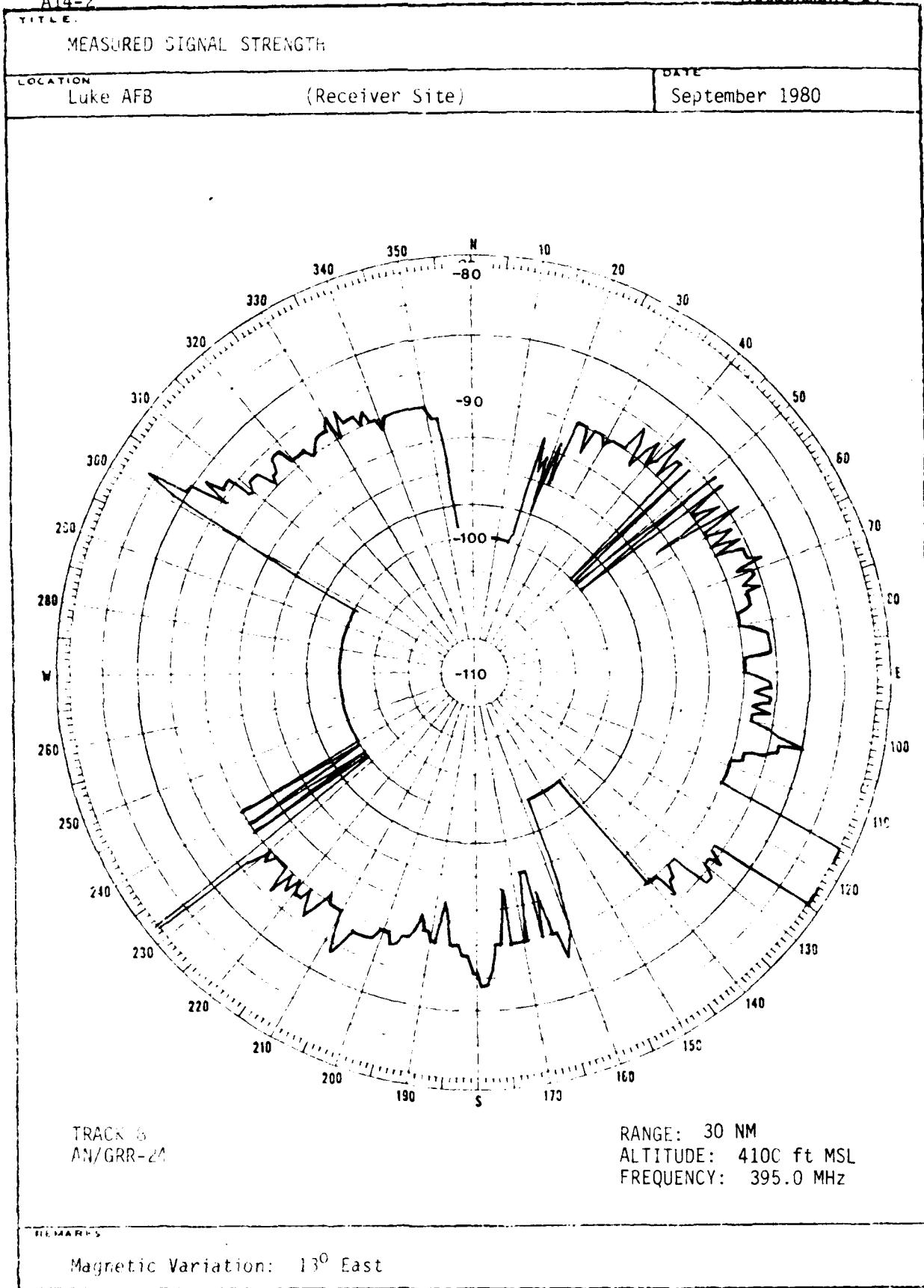
| LOCATION | | DATE | | | | | | |
|-----------------------------------|---------|-----------------|--------|--------------------|--------|----------------|--------|--------|
| Luke AFB | | (Control Tower) | | | | September 1980 | | |
| TRANSMIT SIDE | | | | | | | | |
| FREQUENCY. | MHz | 256.9 | 121.5 | 243.0 | 289.6 | 126.2 | 335.8 | 395.0 |
| Control Tower | | | | | | | | |
| MIC AMP IN | dBm | | -35.0 | -35.0 | -35.0 | -35.0 | -35.0 | -35.0 |
| MIC AMP OUT | dBm | | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 |
| CABLE OUT | dBm | | 0.0 | 0.0 | 3.0* | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | | 32.2 | 32.0 | 33.0 | 32.2 | 32.0 | 32.0 |
| NOISE LEVEL | dBm | | -79.0 | -75.0 | -85.0 | -87.0 | -85.0 | -84.0 |
| Transmitter Site | | | | | | | | |
| CABLE IN | dBm | TRANSMITTER | -9.4 | -7.6 | -6.4 | -1.8 | -2.0 | -2.0 |
| NOISE FLOOR | dB Down | ON | 32.6 | 32.8 | 33.2 | 33.0 | 32.2 | 32.0 |
| NOISE LEVEL | dBm | | -63.0 | -65.0 | -63.0 | -76.0 | -75.0 | -76.0 |
| RECEIVE SIDE | | | | | | | | |
| Receiver Site | | | | | | | | |
| CABLE OUT | dBm | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | 23.0 | 23.0 | 21.6 | 23.6 | 21.2 | 18.0 | 21.0 |
| NOISE LEVEL | dBm | -55.0 | -37.2* | -53.0 | -55.4 | -64.0 | -50.0 | -54.5 |
| Control Tower | | | | | | | | |
| CABLE IN | dBm | -2.4 | -6.0 | -6.0 | -3.0 | -3.2 | -2.8 | -2.6 |
| NOISE FLOOR | dB Down | 25.0 | 24.0 | 22.0 | 25.0 | 23.0 | 19.0 | 23.0 |
| NOISE LEVEL | dBm | -38.0* | -43.0 | -45.0 | -38.0* | -40.0 | -37.0* | -38.0* |
| Line AMP IN | dBm | -2.4 | -6.0 | -6.0 | -3.0 | -3.2 | -2.8 | -2.6 |
| Line AMP OUT | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| NOISE FLOOR | dB Down | 23.0 | 20.0 | 22.0 | 22.0 | 18.0 | 18.0 | 21.6 |
| NOISE LEVEL | dBm | -32.0* | -27.0* | -29.0* | -28.0* | -46.0* | -27.0* | -33.0* |
| REMARKS | | | | | | | | |
| ** ICU set at minimum attenuation | | | | * Out of tolerance | | | | |

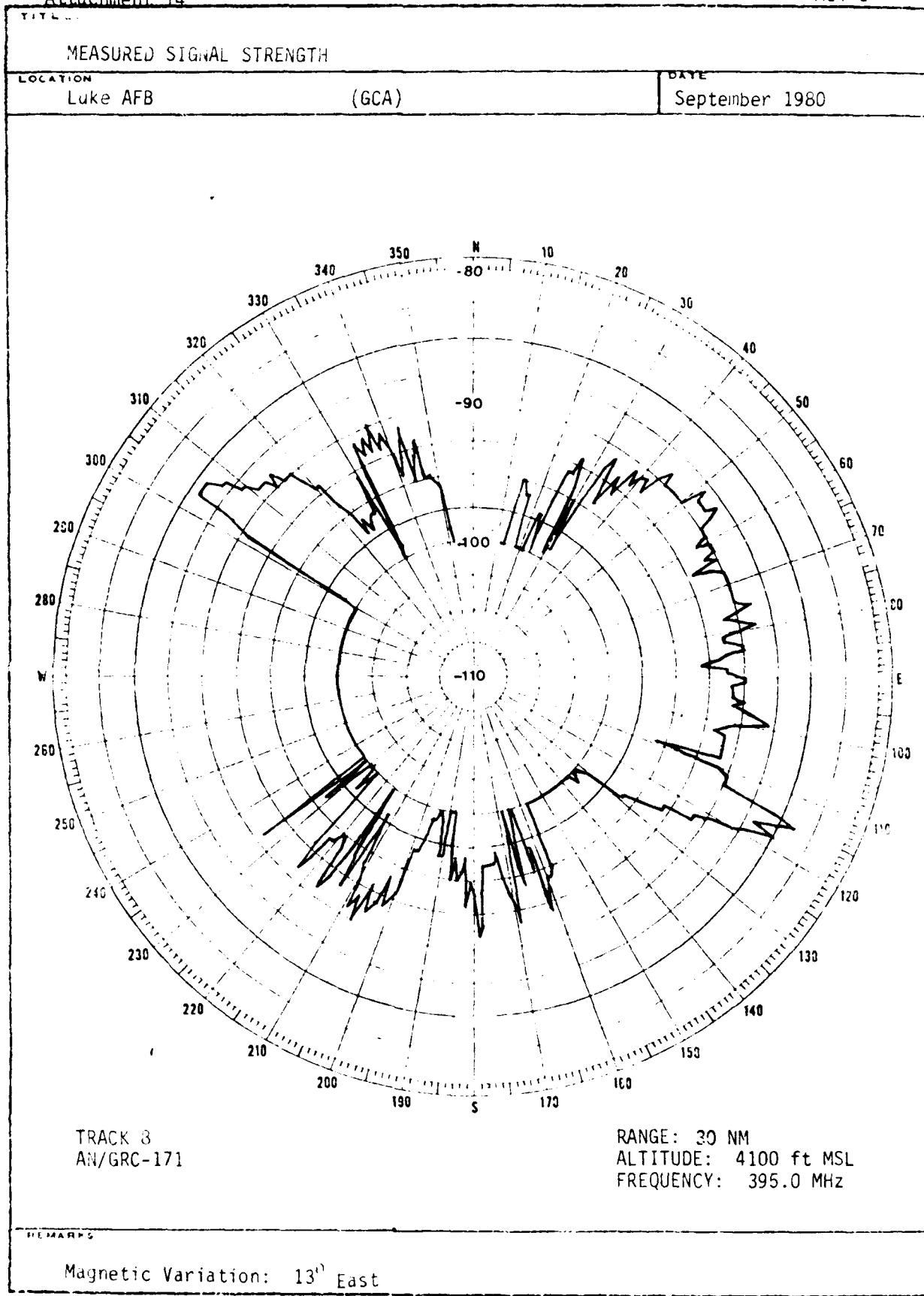
| AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS | | | | | | | |
|--|---------|--------|--------|----------------|--------|--------|-------|
| LOCATION | | | | DATE | | | |
| Luke AFB (GCA) | | | | September 1980 | | | |
| TRANSMIT SIDE | | | | | | | |
| FREQUENCY: | MHz | 121.5 | 389.8 | 301.5 | 349.7 | 243.0 | 257.2 |
| GCA | | | | | | | |
| MIC AMP IN | dBm | -35.0 | -35.0 | -35.0 | -35.0 | -35.0 | -35.0 |
| MIC AMP OUT | dBm | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 |
| CABLE OUT | dBm | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | 31.0 | 30.8 | 30.0 | 28.0 | 29.0 | 28.0 |
| NOISE LEVEL | dBm | -64.0 | -67.0 | -67.0 | -67.0 | -63.0 | -66.0 |
| Transmitter Site | | | | | | | |
| CABLE IN | dBm | -2.2 | -2.2 | -2.8 | -2.2 | -2.6 | -2.0 |
| NOISE FLOOR | dB Down | 33.0 | 33.0 | 33.0 | 33.0 | 32.0 | 33.0 |
| NOISE LEVEL | dBm | -62.0 | -67.5 | -68.0 | -67.0 | -63.0 | -66.0 |
| RECEIVE SIDE | | | | | | | |
| Receiver Site | | | | | | | |
| CABLE OUT | dBm | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | 21.0 | 24.6 | 23.5 | 20.0 | 21.0 | 26.0 |
| NOISE LEVEL | dBm | -36.5* | -56.0 | -53.0 | -60.0 | -53.5 | -57.0 |
| GCA | | | | | | | |
| CABLE IN | dBm | -5.5 | -2.4 | -2.5 | -2.4 | -5.6 | -2.0 |
| NOISE FLOOR | dB Down | 24.0 | 25.1 | 24.5 | 21.0 | 21.0 | 26.0 |
| NOISE LEVEL | dBm | -45.0 | -58.5 | -56.0 | -62.0 | -58.5 | -59.0 |
| LINE AMP IN | dBm | -5.5 | -2.4 | -2.5 | -2.4 | -5.6 | -2.0 |
| LINE AMP OUT | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| NOISE FLOOR | dB Down | 18.0 | 24.5 | 21.0 | 17.5 | 20.0 | 21.5 |
| NOISE LEVEL | dBm | -27.0* | -33.5* | -28.5* | -34.0* | -29.0* | -40.0 |
| REMARKS | | | | | | | |
| * Out of tolerance | | | | | | | |

| AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS | | | | | | |
|--|---------|---------|--------|--------|--------|--------|
| LOCATION | (GCA) | | | DATE | | |
| TRANSMIT SIDE | | | | | | |
| FREQUENCY: | MHz | 134.1 | 388.9 | 291.1 | 372.9 | 349.0 |
| GCA | | | | | | |
| MIC AMP IN | dBm | -35.0 | -35.0 | -35.0 | -35.0 | -35.0 |
| MIC AMP OUT | dBm | 19.4 | 19.4 | 19.4 | 19.4 | 19.4 |
| CABLE OUT | dBm | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | 31.0 | 29.0 | 29.0 | 29.0 | 29.0 |
| NOISE LEVEL | dBm | -66.0 | -66.0 | -65.0 | -66.0 | -66.0 |
| Transmitter Site | | | | | | |
| CABLE IN | dBm | -2.1 | -2.1 | -2.0 | -2.0 | -2.3 |
| NOISE FLOOR | dB Down | 33.0 | 32.8 | 32.8 | 33.0 | 29.0 |
| NOISE LEVEL | dBm | -67.0 | -66.0 | -65.0 | -67.0 | -66.0 |
| RECEIVE SIDE | | | | | | |
| Receiver Site | | | | | | |
| CABLE OUT | dBm | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOISE FLOOR | dB Down | 19.0 | 17.0 | 17.0 | 18.0 | 23.5 |
| NOISE LEVEL | dBm | -49.0 | -54.0 | -52.0 | -51.5 | -53.0 |
| GCA | | | | | | |
| CABLE IN | dBm | -2.2 | -2.6 | -2.4 | -2.6 | -2.4 |
| NOISE FLOOR | dB Down | 18.0 | 18.0 | 16.5 | 18.0 | 24.2 |
| NOISE LEVEL | dBm | -52.4 | -57.0 | -55.5 | -55.0 | -56.4 |
| LINE AMP IN | dBm | -2.2 | -2.6 | -2.4 | -2.6 | -2.4 |
| LINE AMP OUT | dBm | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| NOISE FLOOR | dB Down | 18.8 | 15.5 | 16.0 | 18.0 | 22.2 |
| NOISE LEVEL | dBm | -13.0** | -3.0** | -5.0** | -6.5** | -6.0** |
| REMARKS | | | | | | |
| ** Replaced power supply and levels dropped to -60dBm or less. | | | | | | |

| TITLE | | FLIGHT PROFILE | | | |
|--------------------------------|------------------------|-------------------|-------------|---------------|------------|
| LOCATION | | DATE | | | |
| Luke AFB | | September 1980 | | | |
| Track | Track Description | Altitude (ft MSL) | Antenna | Power (Watts) | Date Flown |
| 1 | R-208 Out | 5100 | RX-R1/GCA-3 | 10 | 5 Oct |
| 2 | R-208 In | 4100 | RX-B1/GCA-3 | 10 | 5 Oct |
| 3 | R-044 Out | 6500 | RX-B1/GCA-3 | 10 | 5 Oct |
| 4 | R-044 In | 4500 | RX-B1/GCA-3 | 10 | 5 Oct |
| 5 | R-310 Out | 6200 | RX-B1/GCA-3 | 10 | 5 Oct |
| 6 | R-310 In | 4200 | RX-B1/GCA-3 | 10 | 5 Oct |
| 7 | R-130 Out | 4100 | RX-B1/GCA-3 | 10 | 5 Oct |
| 8 | 30 iIM Orbit | 4100 | RX-B1/GCA-3 | 10 | 5 Oct |
| 9 | R-130 In | 3100 | RX-B1/GCA-3 | 10 | 5 Oct |
| 10 | R-270 Out | 5200 | RX-B1/GCA-3 | 10 | 5 Oct |
| 11 | R-270 In | 4200 | RX-B1/GCA-3 | 10 | 5 Oct |
| 12 | R-208 Out | 7100 | TX-3 | 10 | 5 Oct |
| 13 | R-208 In | 4100 | TX-3 | 10 | 5 Oct |
| 14 | R-044 Out | 6500 | TX-3 | 10 | 5 Oct |
| 15 | R-044 In | 4500 | TX-3 | 10 | 5 Oct |
| 16 | R-310 Out | 6200 | TX-3 | 10 | 5 Oct |
| 17 | R-310 In | 4200 | TX-3 | 10 | 5 Oct |
| 18 | R-130 Out | 4100 | TX-3 | 10 | 5 Oct |
| 19 | 30 NM Orbit | 4100 | TX-3 | 10 | 5 Oct |
| 20 | R-130 In | 3100 | TX-3 | 10 | 5 Oct |
| 21 | R-270 Out | 5200 | TX-3 | 10 | 5 Oct |
| 22 | R-270 In | 4200 | TX-3 | 10 | 5 Oct |
| 23 | ARC 290°-330° 20 NM | 1000 AGL | RX-B1 | 10 | 5 Oct |
| 24 | ARC 290°-330° 20 NM | 1000 AGL | TX-3 | 10 | 5 Oct |
| REMARKS | | | | | |
| * R = Radial | | | | | |
| 395.0 MHz used for all tracks. | | | | | |







HORIZONTAL COVERAGE PREDICTION

Communications coverage predictions can be divided into two areas, RLOS range and free space loss. The RLOS predictions are based on the surveyed horizon screening angles and the radio horizon with standard refractive conditions. Predicted RLOS range is derived from the following equation:

$$R = \frac{-160a + \sqrt{(160a)^2 + 4(A-E)(1.507784)}}{2}$$

a = Screening angle

R = Range (NM)

A-E = Difference between transmit and receive antenna heights (ft AGL)

The RLOS plots generated using this formula are a worst case prediction of communications range, but can be useful in determining areas of coverage degradation. In reality, communications coverage is usually ten to thirty percent better than RLOS predictions because of ray diffraction beyond the horizon screens. The RSL predictions are based upon free space loss and the logarithmic characteristics of RF propagation. The area beyond the screening object and below the horizon screening angle is commonly referred to as the shadow zone. In this area, coverage can be more accurately predicted by computing range as a function of minimum RSL. Minimum acceptable RSL is the lowest level at which the ground or airborne receiver squelch circuit will activate. The receiver squelch level for flight inspection aircraft is calibrated to -97.5 dBm; however, the majority of newer aircraft receivers in the Air Force inventory are calibrated to -97 dBm. The ground receiver squelch level is -97.5 dBm for the AN/GRR-23/24/25 receivers. Therefore, most aircraft and all ground receivers are capable of detecting audio on a carrier level of -97.5 dBm or greater. RSL is calculated by equating system losses, antenna gains, and transinit power as follows:

$$RSL = P + G - L - 20 \log(f) - 20 \log(r) - 37.8$$

Where P = Transmitter output power (dBm)

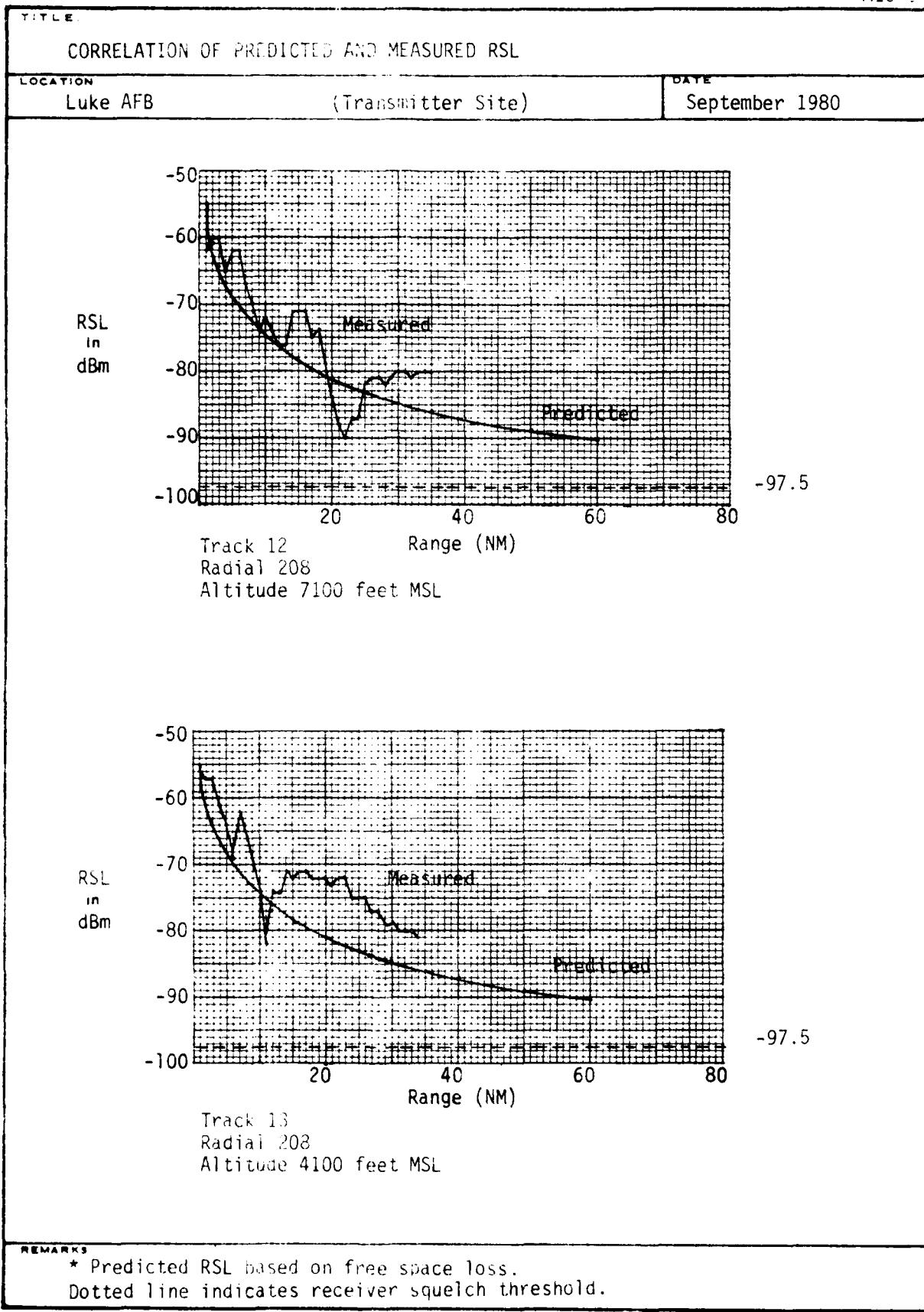
G = Antenna gain (dBi)

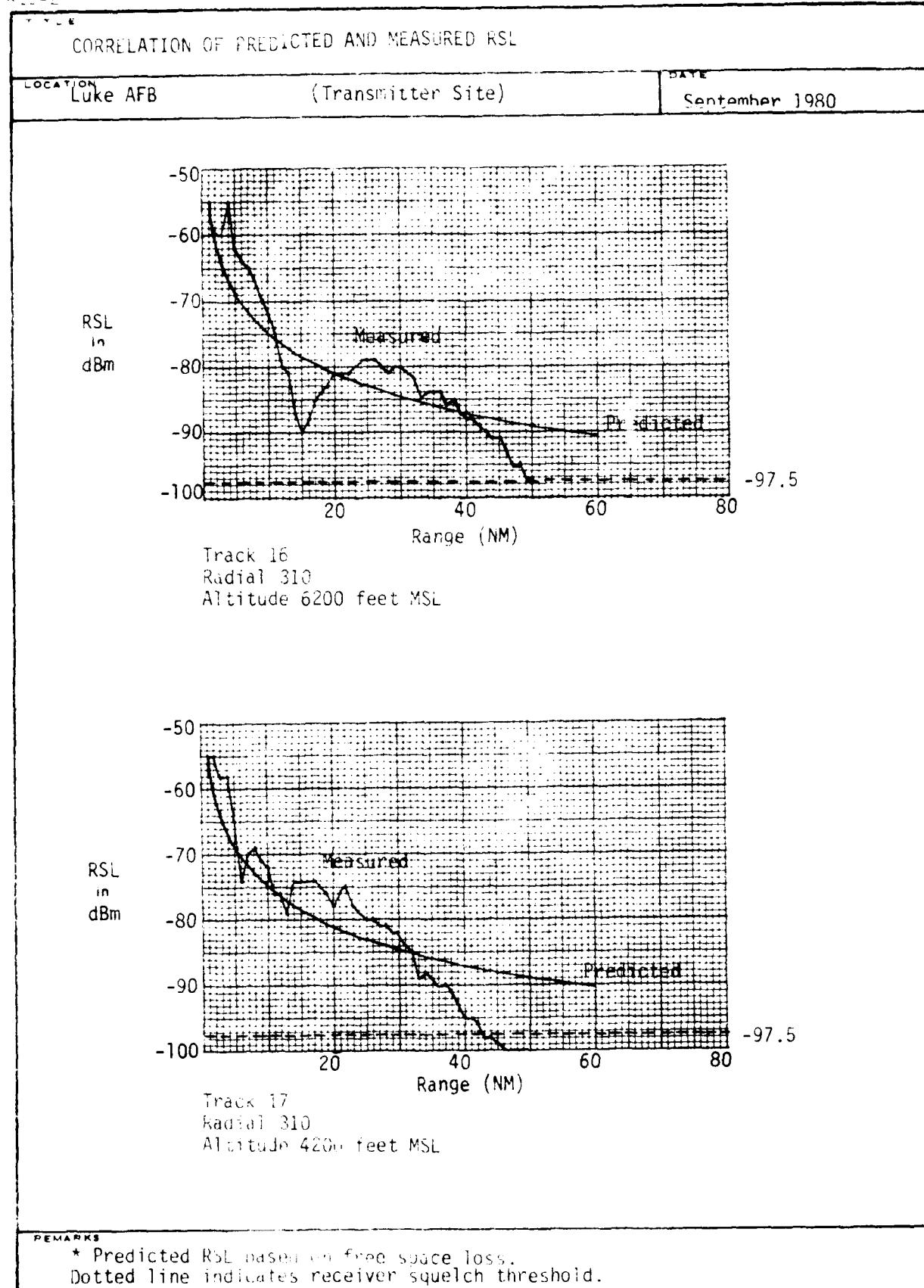
L = Coupler loss and transmission line loss (dB)

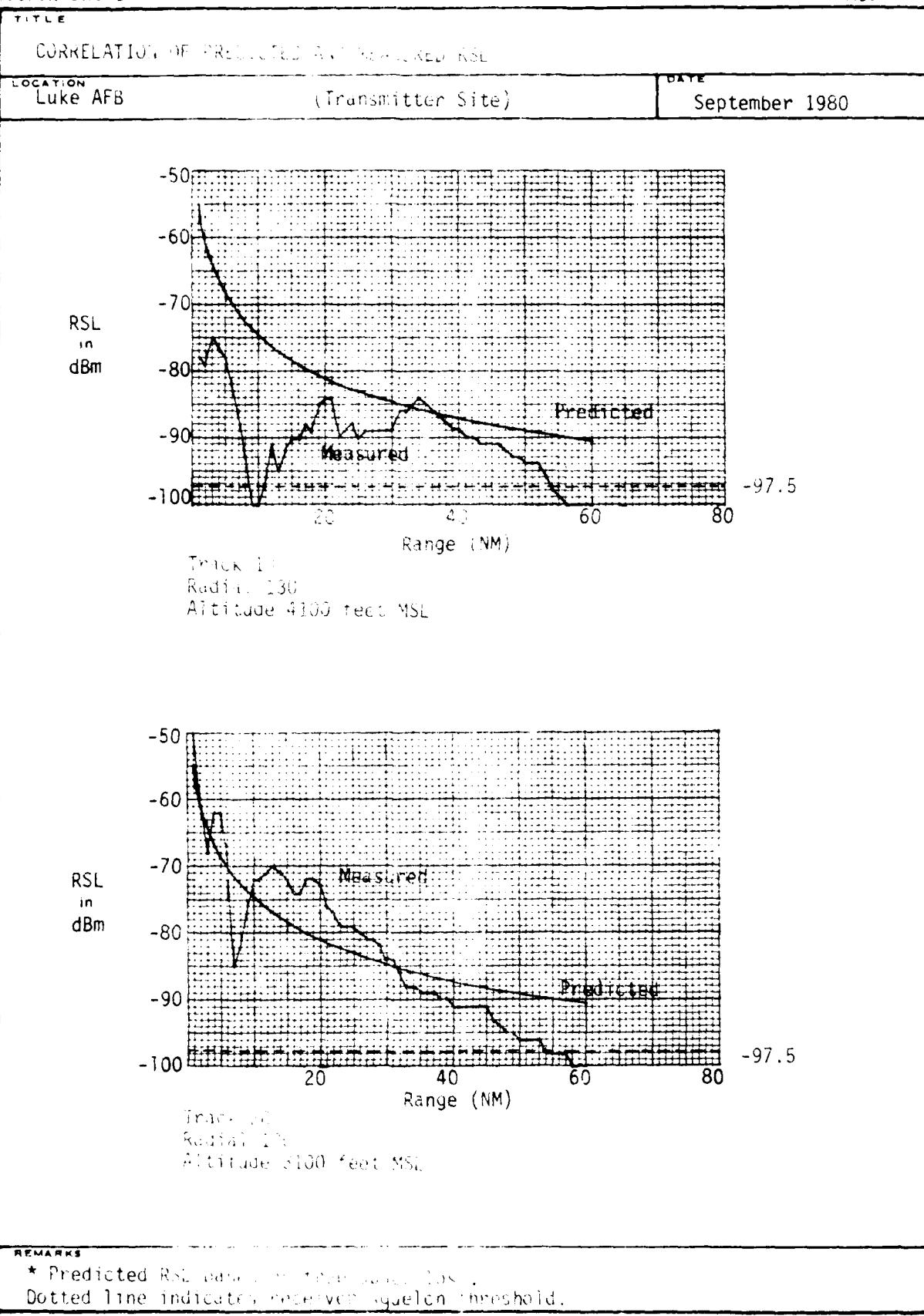
f = Frequency (MHz)

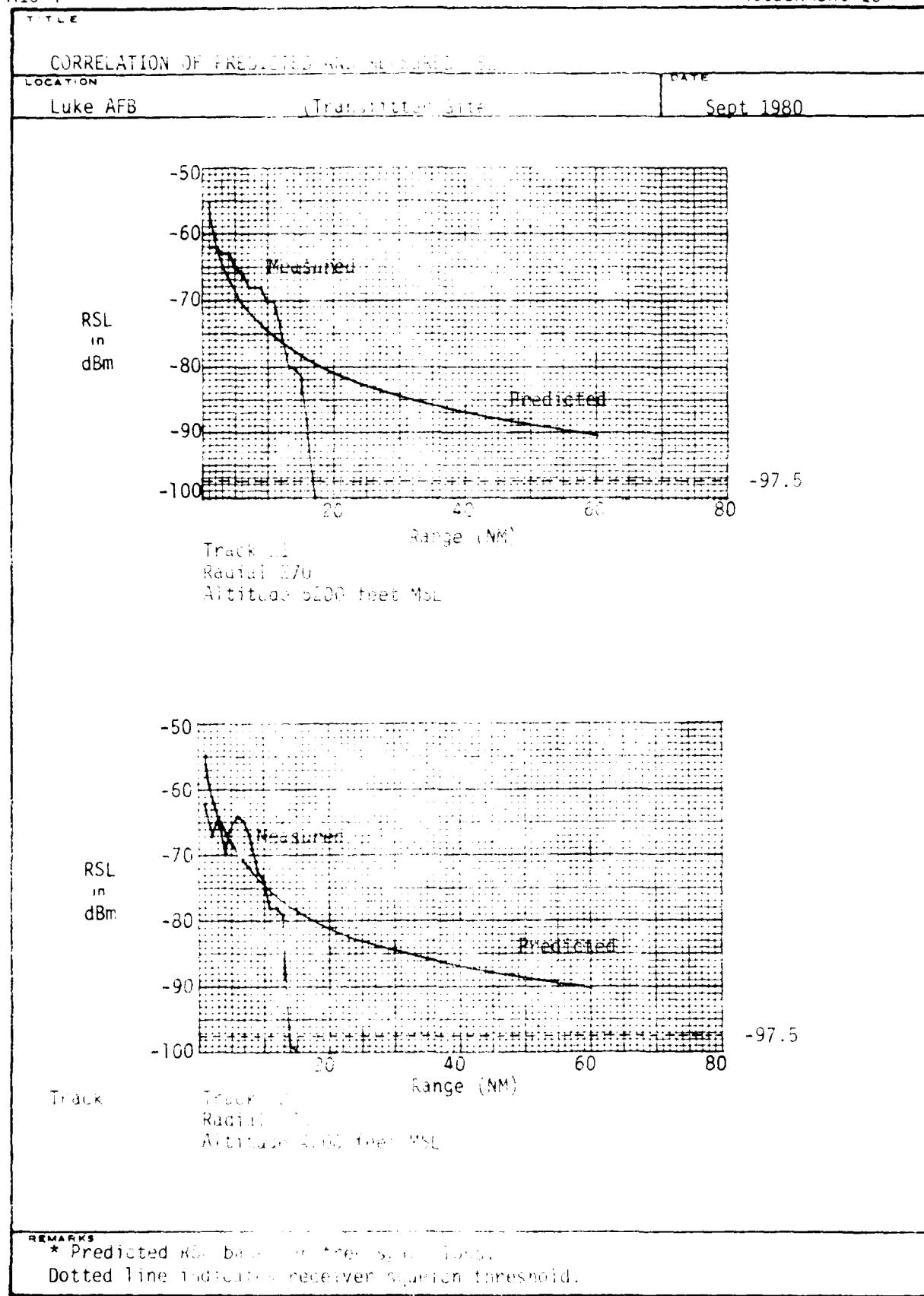
r = Range (NM)

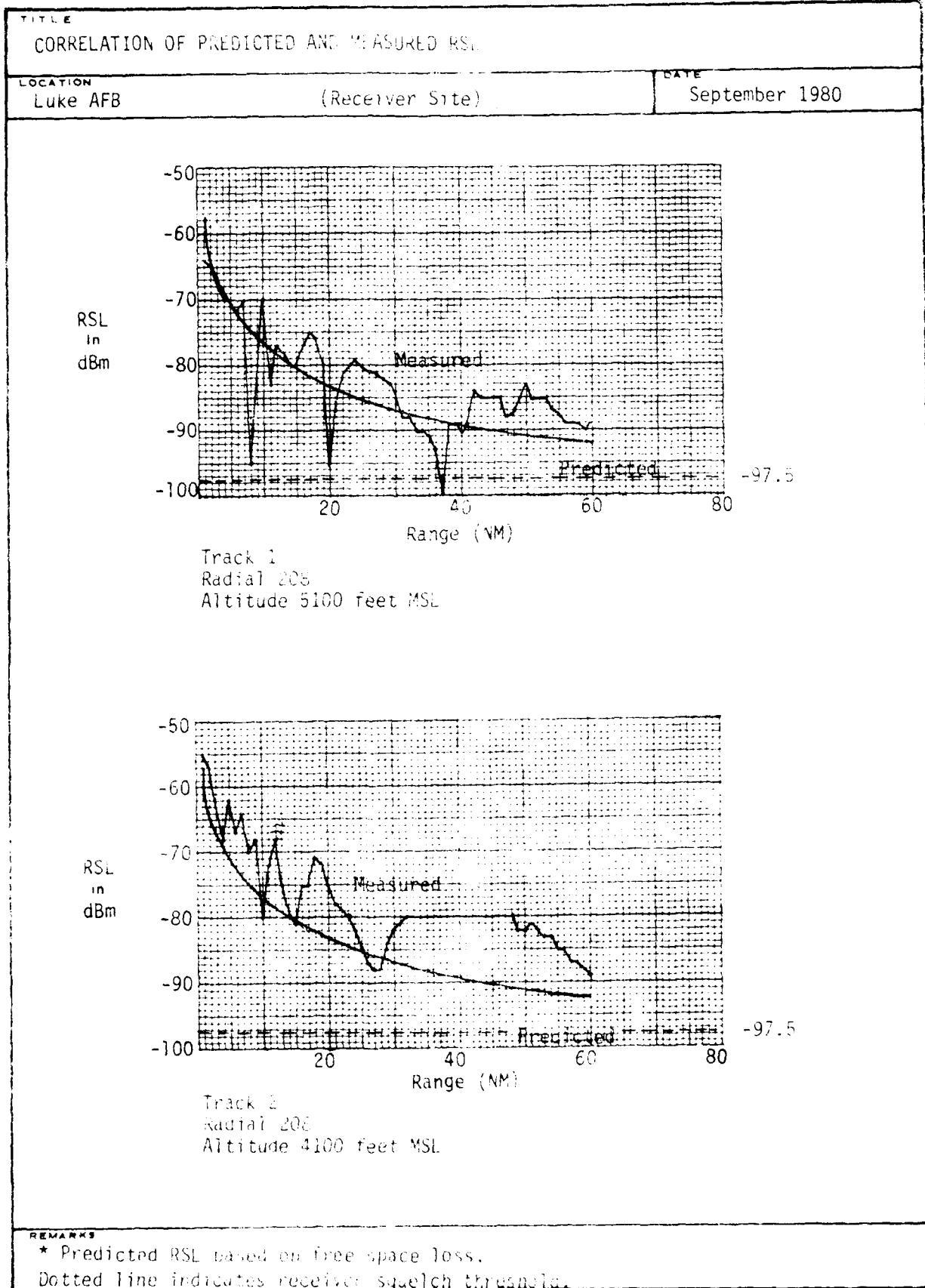
The quantity 37.8 is an accumulation of scaling factors for range in nautical miles, frequency in megahertz, and conversion of RSL from microvolts to dBm.

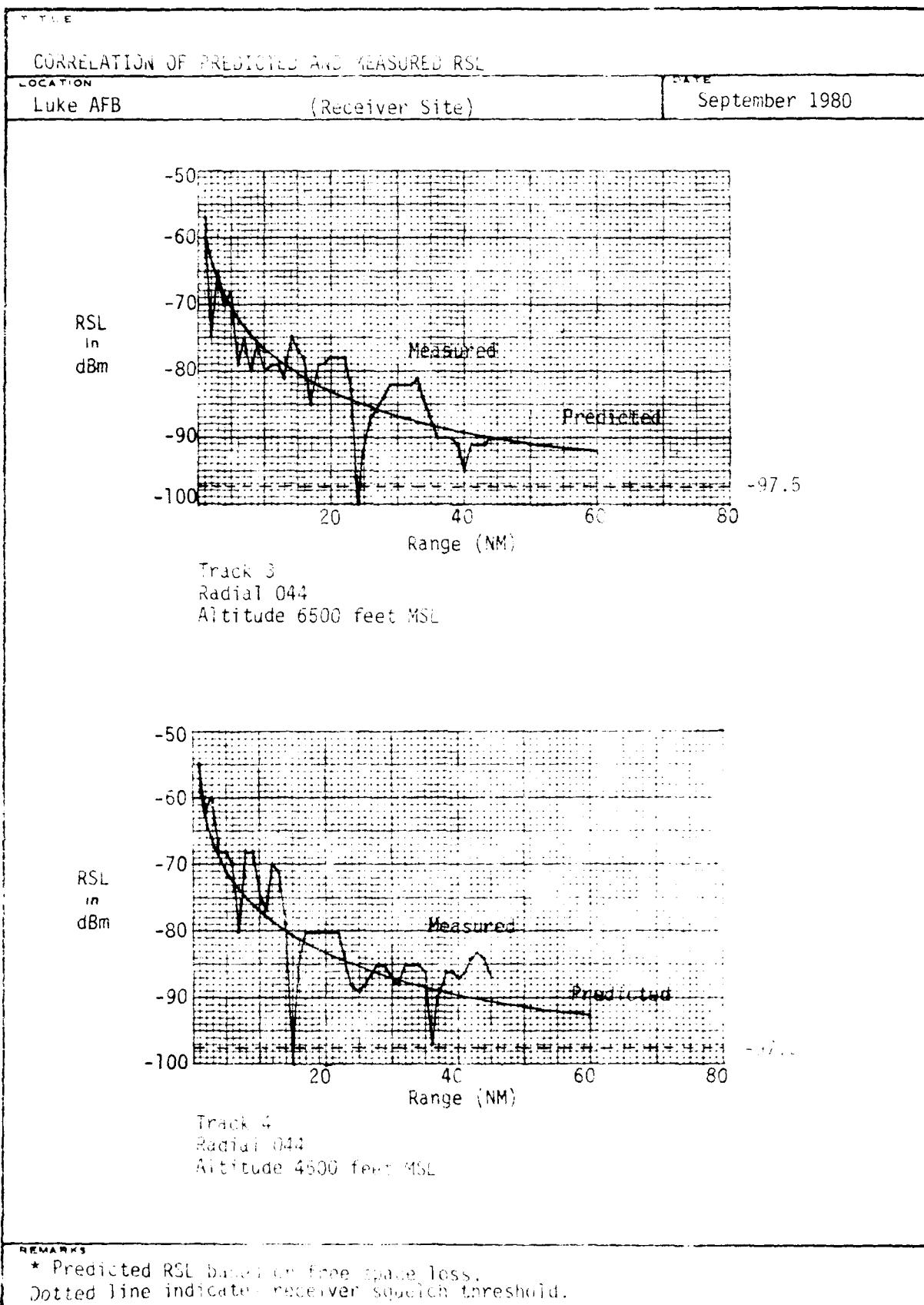


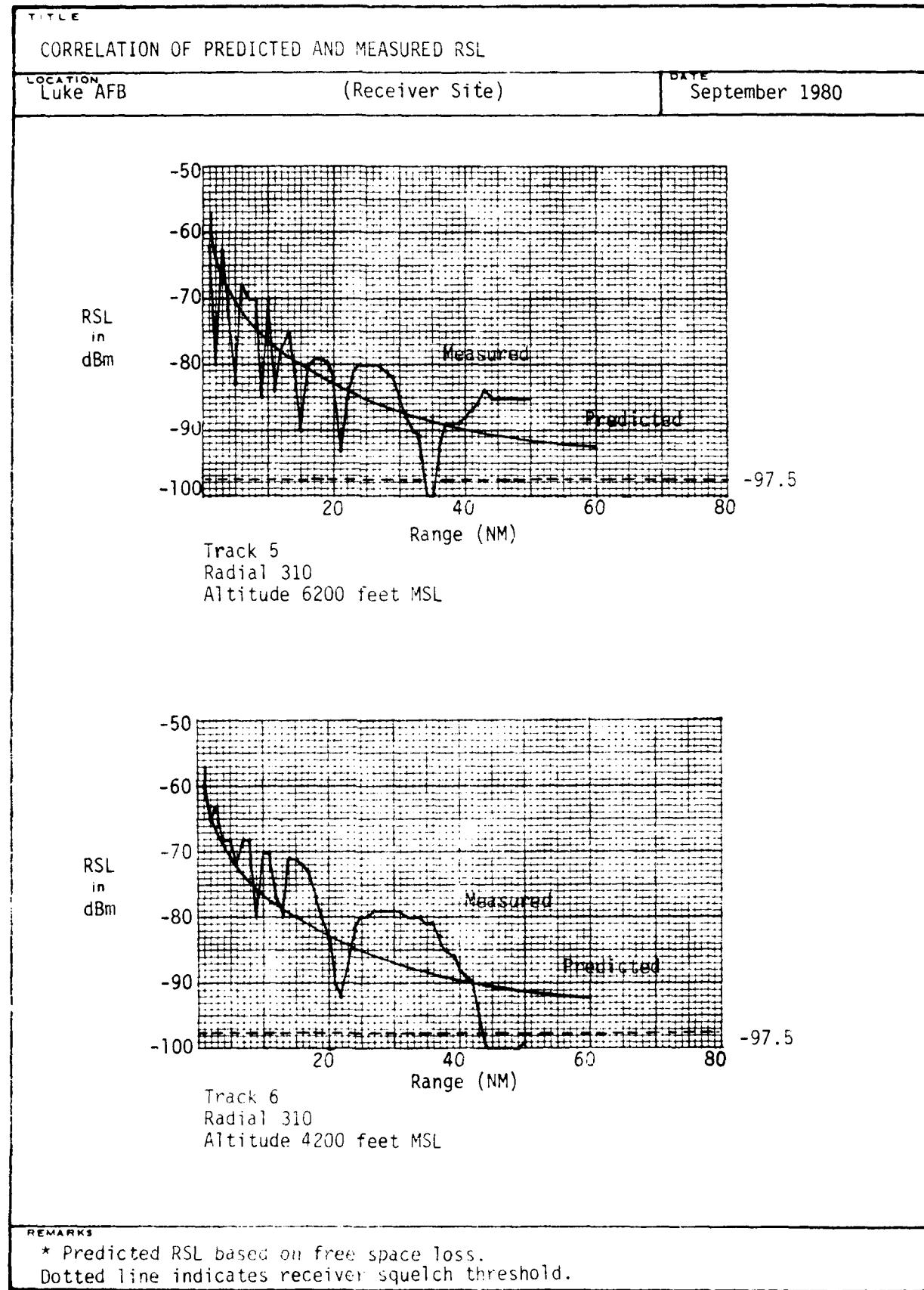


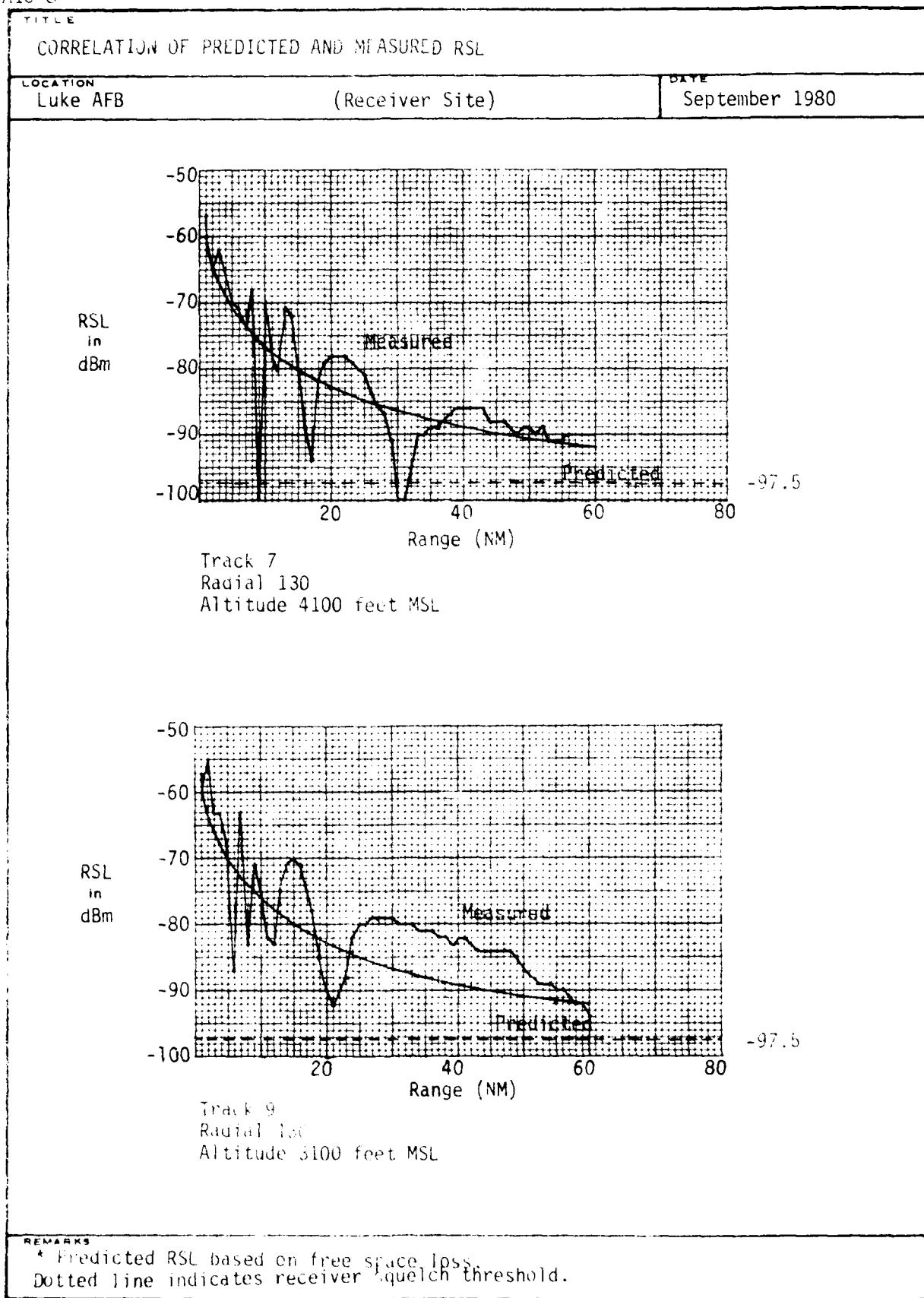


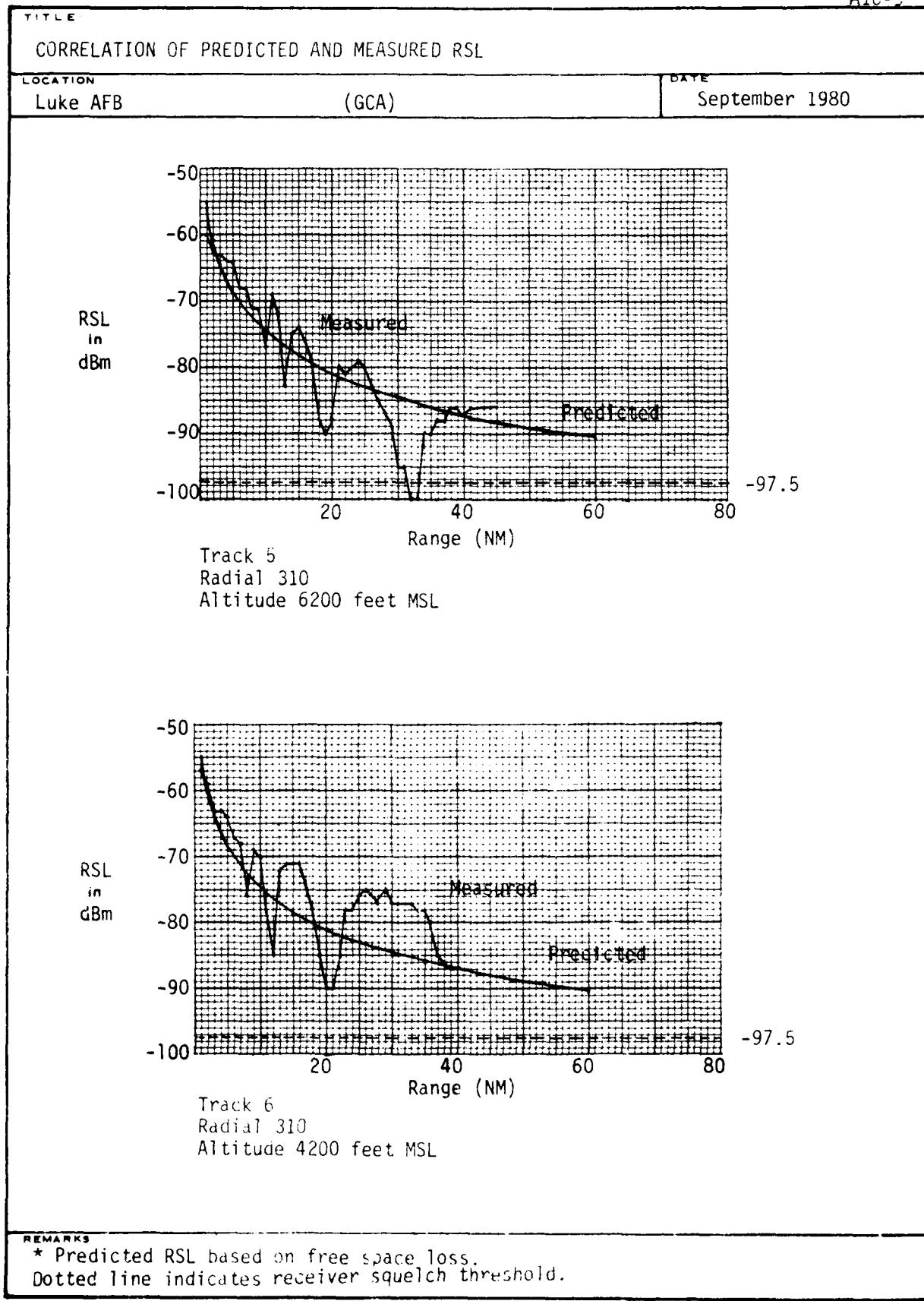


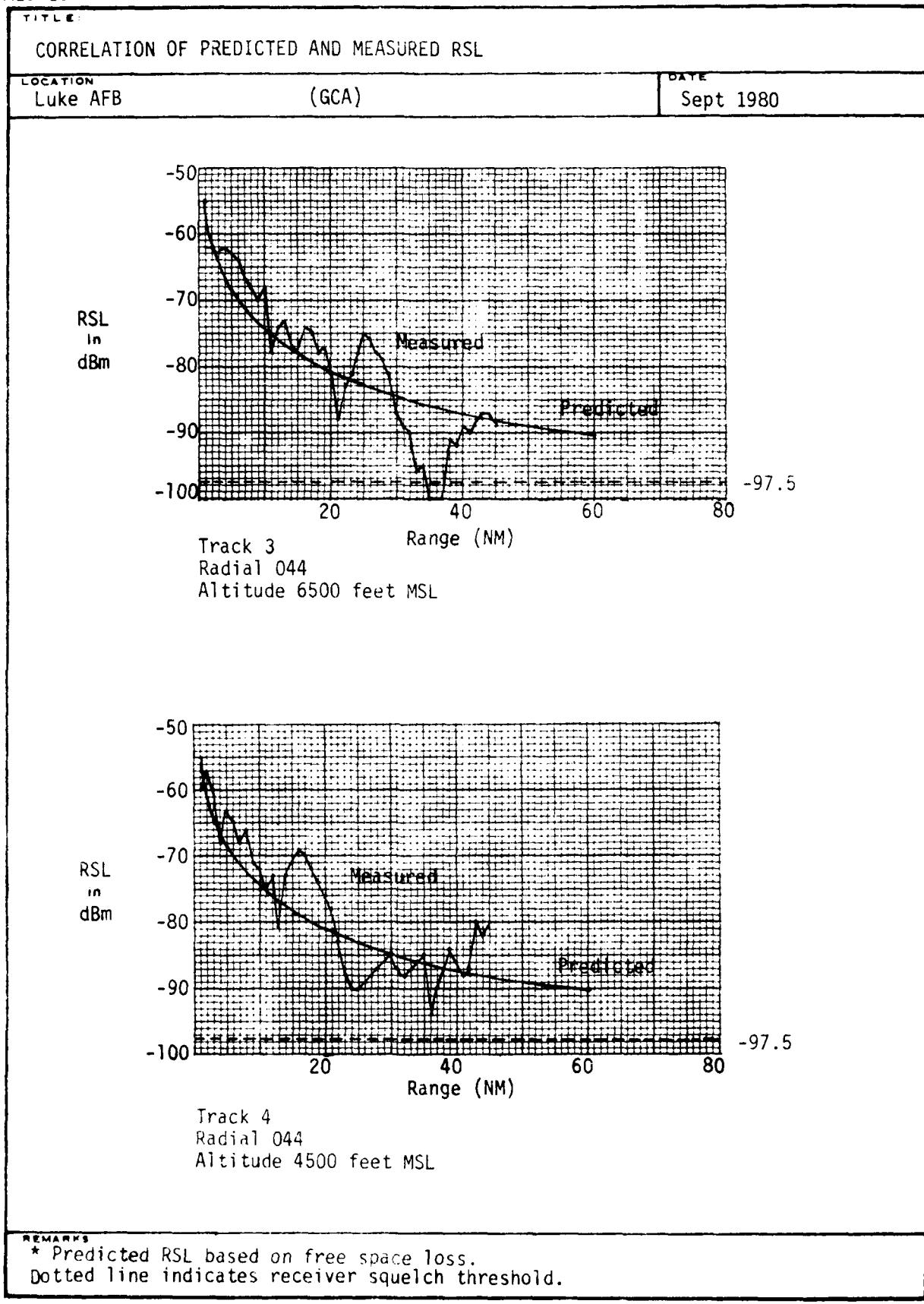


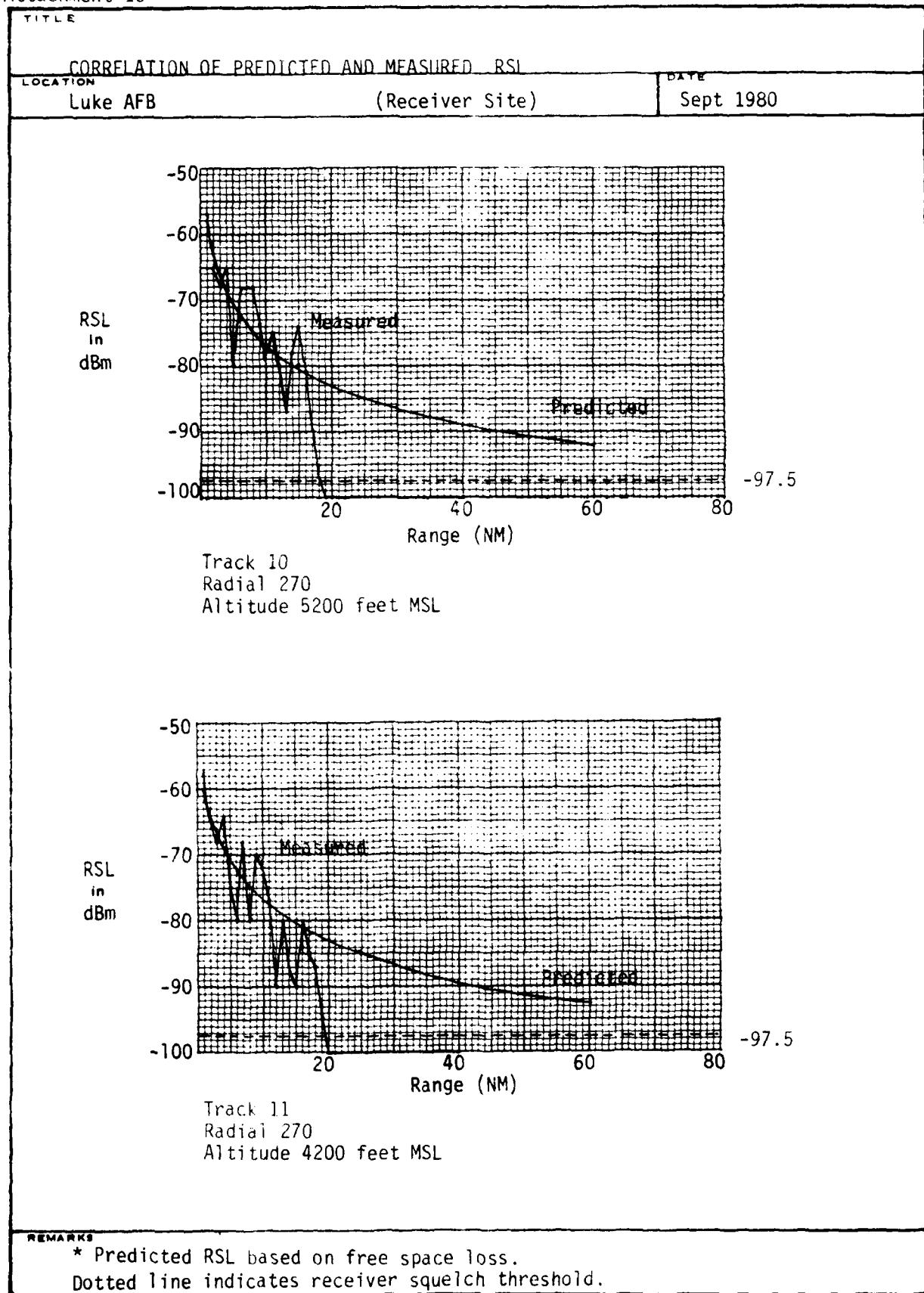


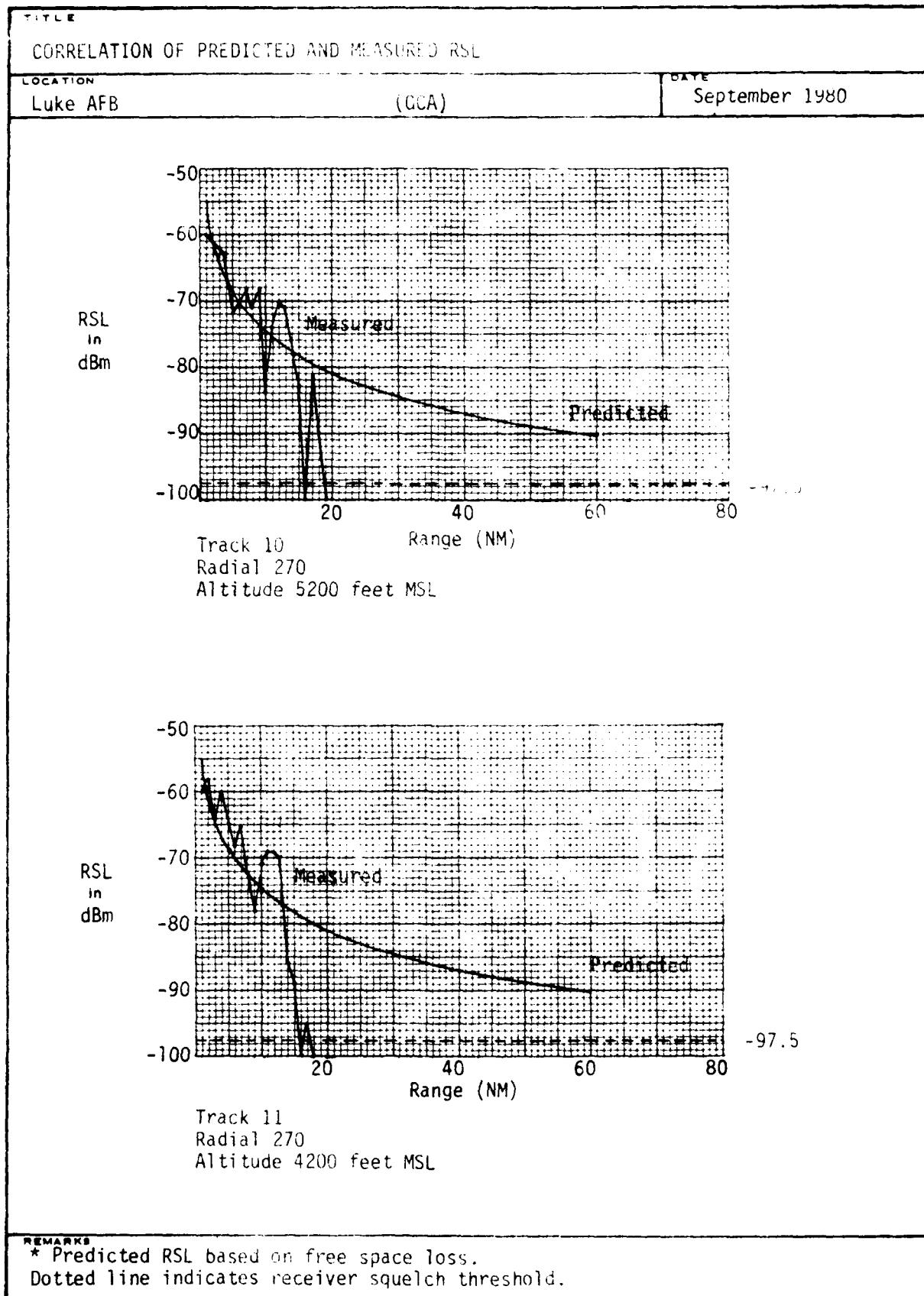






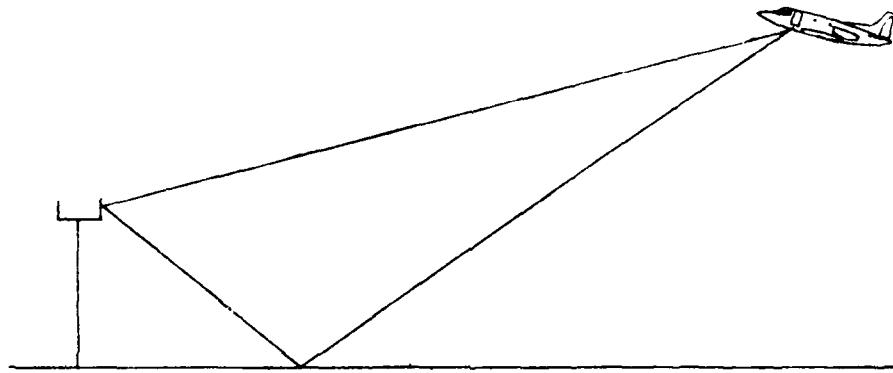






VERTICAL RADIATION PATTERN PREDICTION

1. The vertical radiation pattern is a function of the interference field which consists of a series of maximum and minimum signal strength areas commonly referred to as lobes and nulls, respectively. Multipath propagation causes the interference field to form. The transmitted signal travels over two or more paths, one directly from the transmit antenna to the receive antenna, and the others from the transmit antenna to ground reflection points and then to the receive antenna. The path lengths of the reflected rays are always longer than the direct ray, causing a phase angle difference at the receive antenna. Lobes form when the direct and reflected signal combine in phase (0° phase difference). Out of phase (180° phase difference) combination of direct and reflected signals will cause the formation of nulls.



2. Null angles may be calculated using the formula:

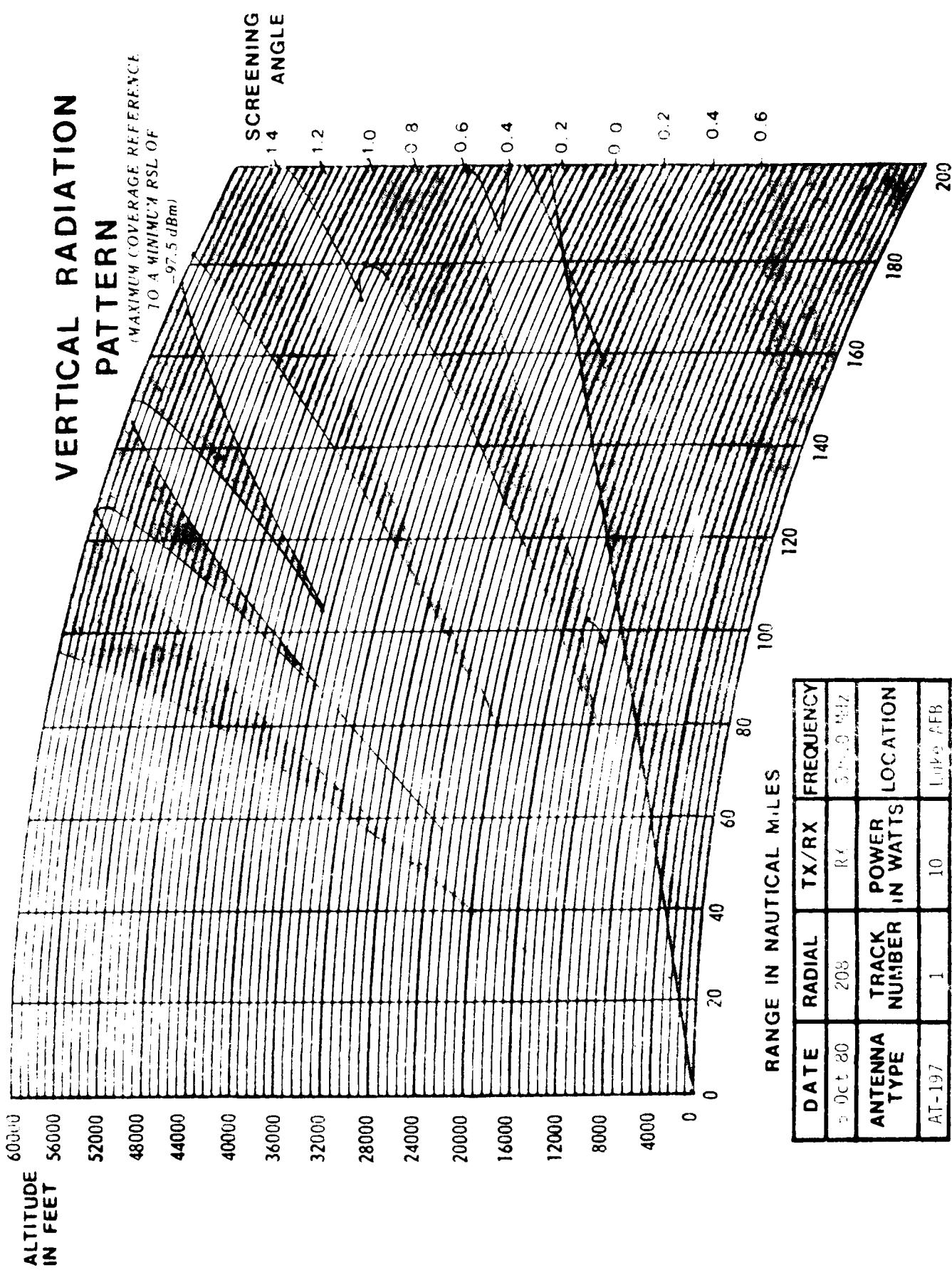
$$\theta = \frac{14098 n}{ha f} \quad n = 2, 4, 6, \dots$$

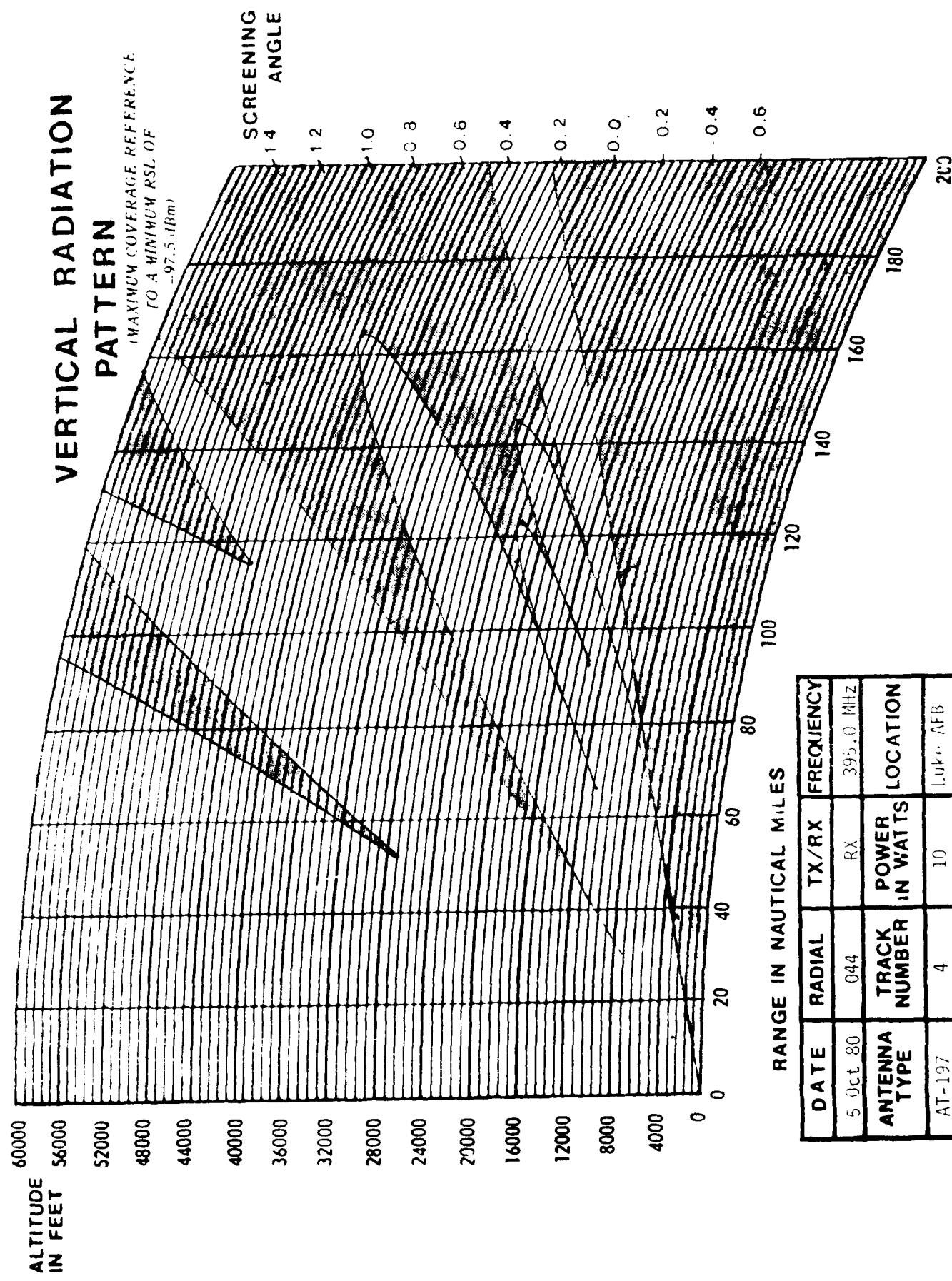
Where θ = null angle in degrees

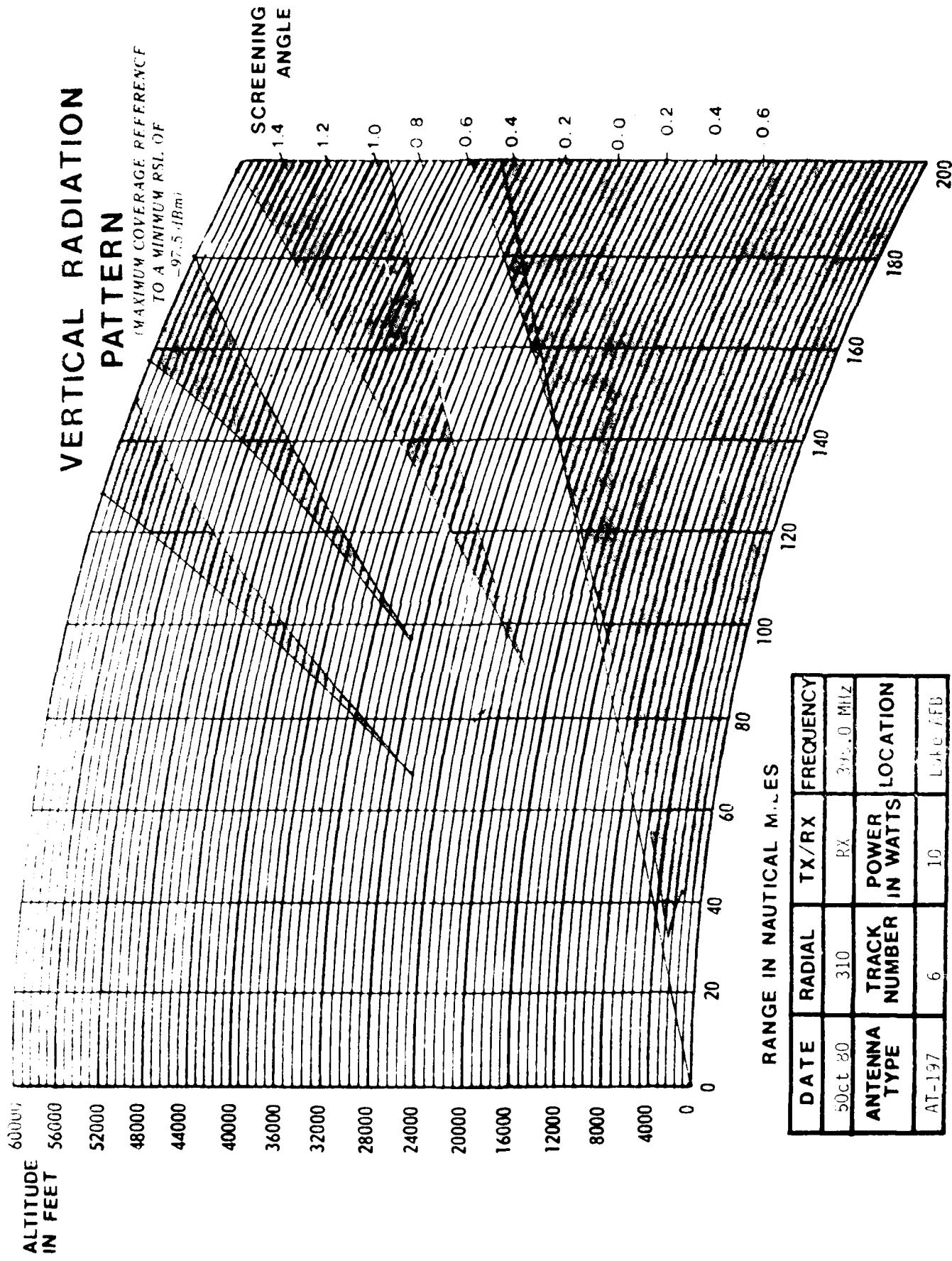
f = frequency in MHz

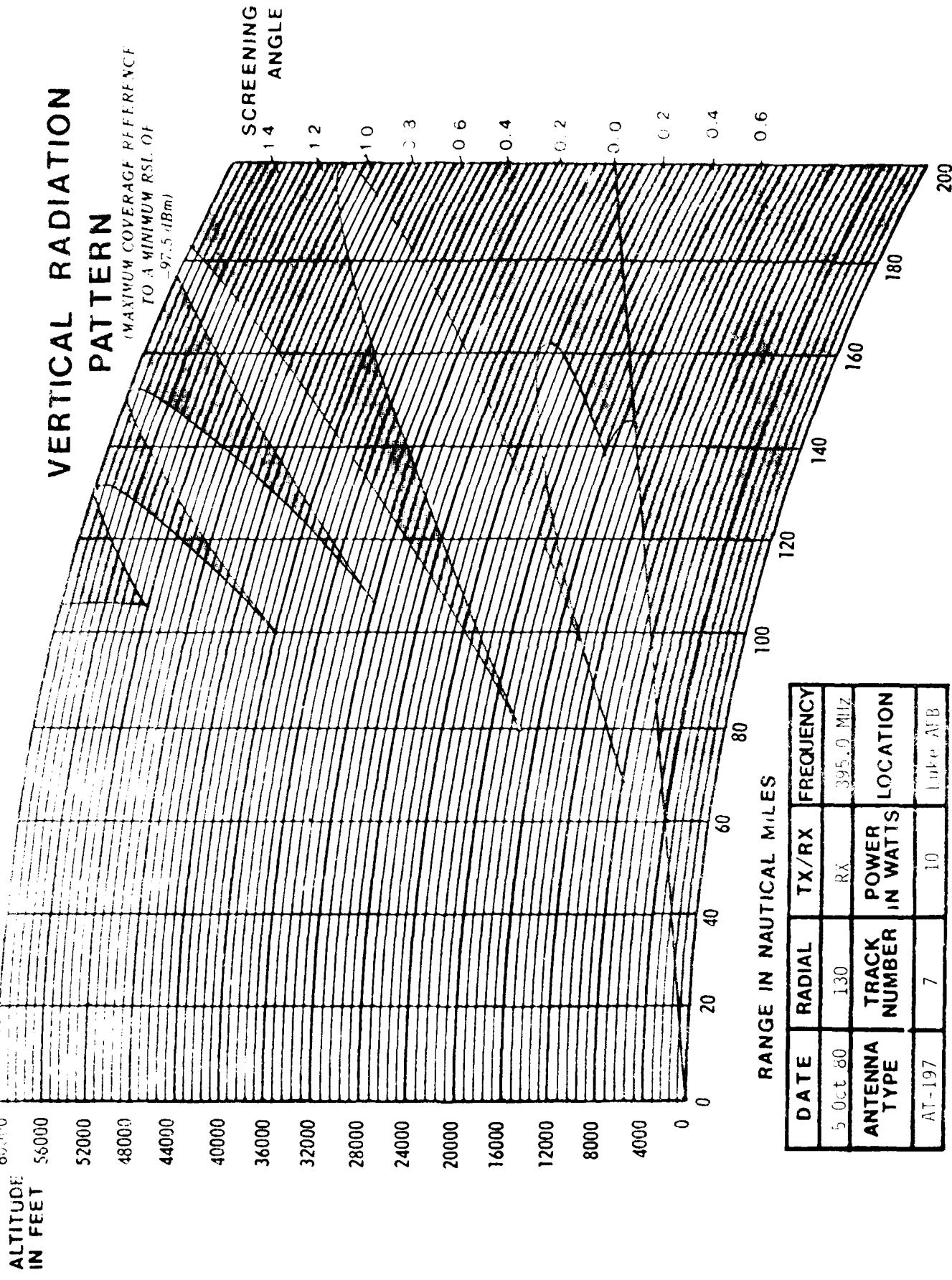
ha = antenna height above terrain in feet

3. The aircraft's high angle of attack and the airborne receiving antenna location (center, bottom of fuselage) cause an overall reduction in signal strength on outbound tracks. Therefore, nulls are more pronounced in the RSL and radiation pattern plots constructed from data collected while flying away from the facility. The nulls appear as sharp reductions in signal strength on the RSL plots and areas of degraded coverage on the vertical radiation plots. The vertical radiation patterns which follow were calculated using the RSL data measured on radial tracks. The predicted null locations, which may represent areas of unacceptable communications, are plotted in the preceding Attachment. The measured null locations, as represented on the RSL and vertical radiation plots usually correlate closely with the predicted null locations on the radials flown.

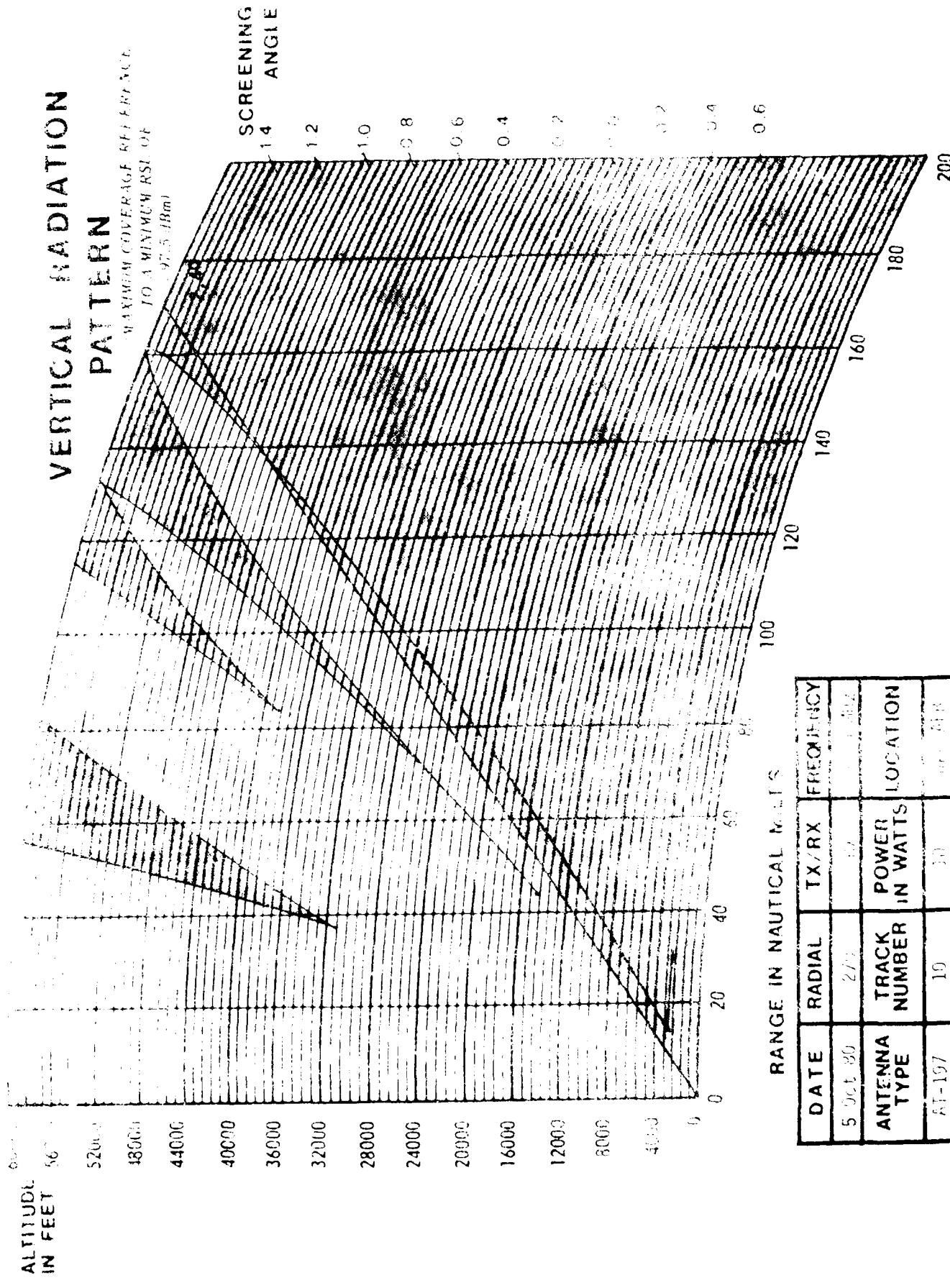






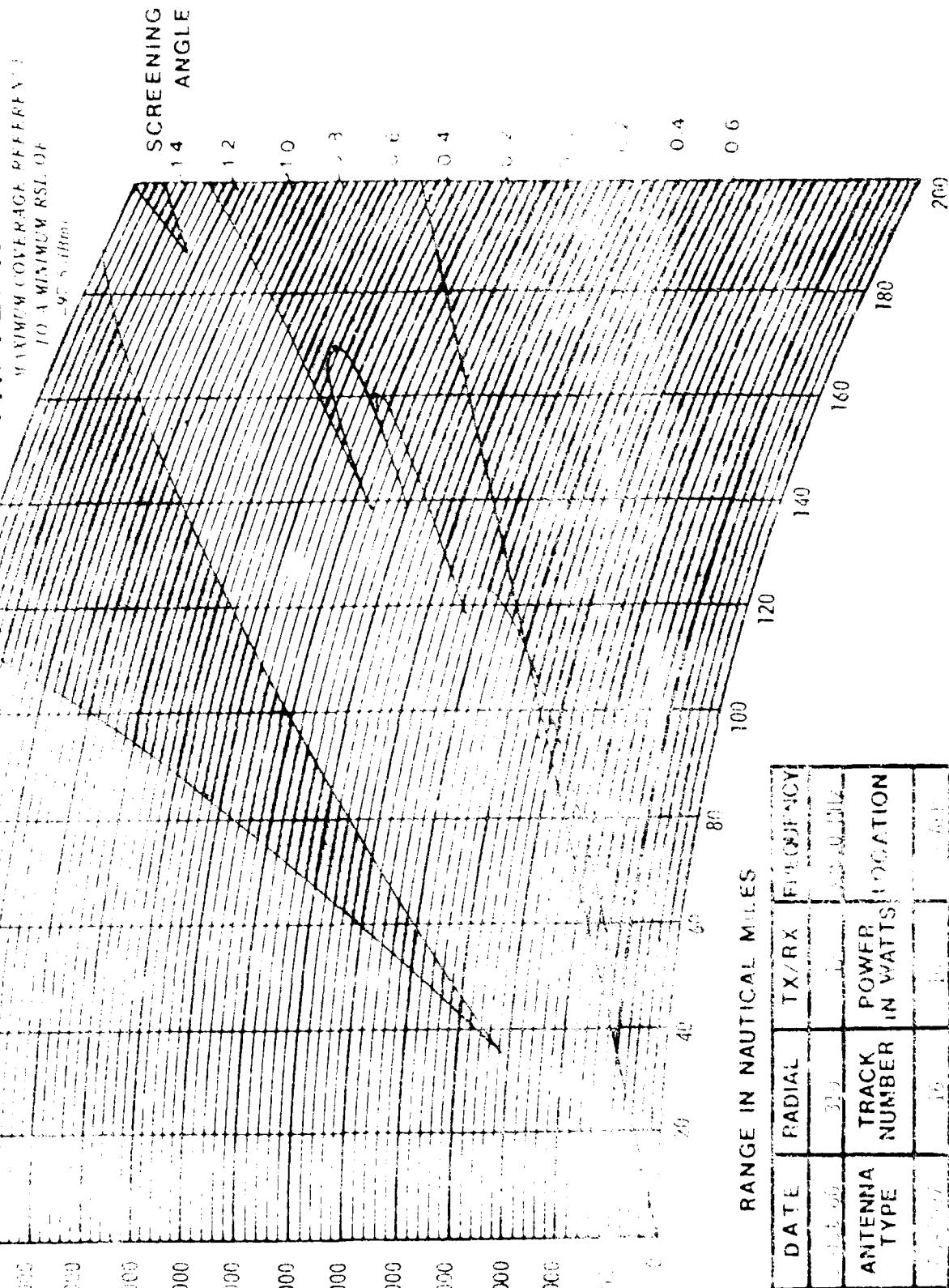


VERTICAL RADIATION PATTERN



| DATE | RADIAL | TX/RX | FREQUENCY |
|--------------|--------------|----------------|-----------------------|
| 5 Oct 80 | Z/11 | TX | 144.000 MHz |
| ANTENNA TYPE | TRACK NUMBER | POWER IN WATTS | LOCATION |
| AT-197 | 19 | 100 | 1000 ft. above ground |

**VERTICAL RADIATION
PATTERN**

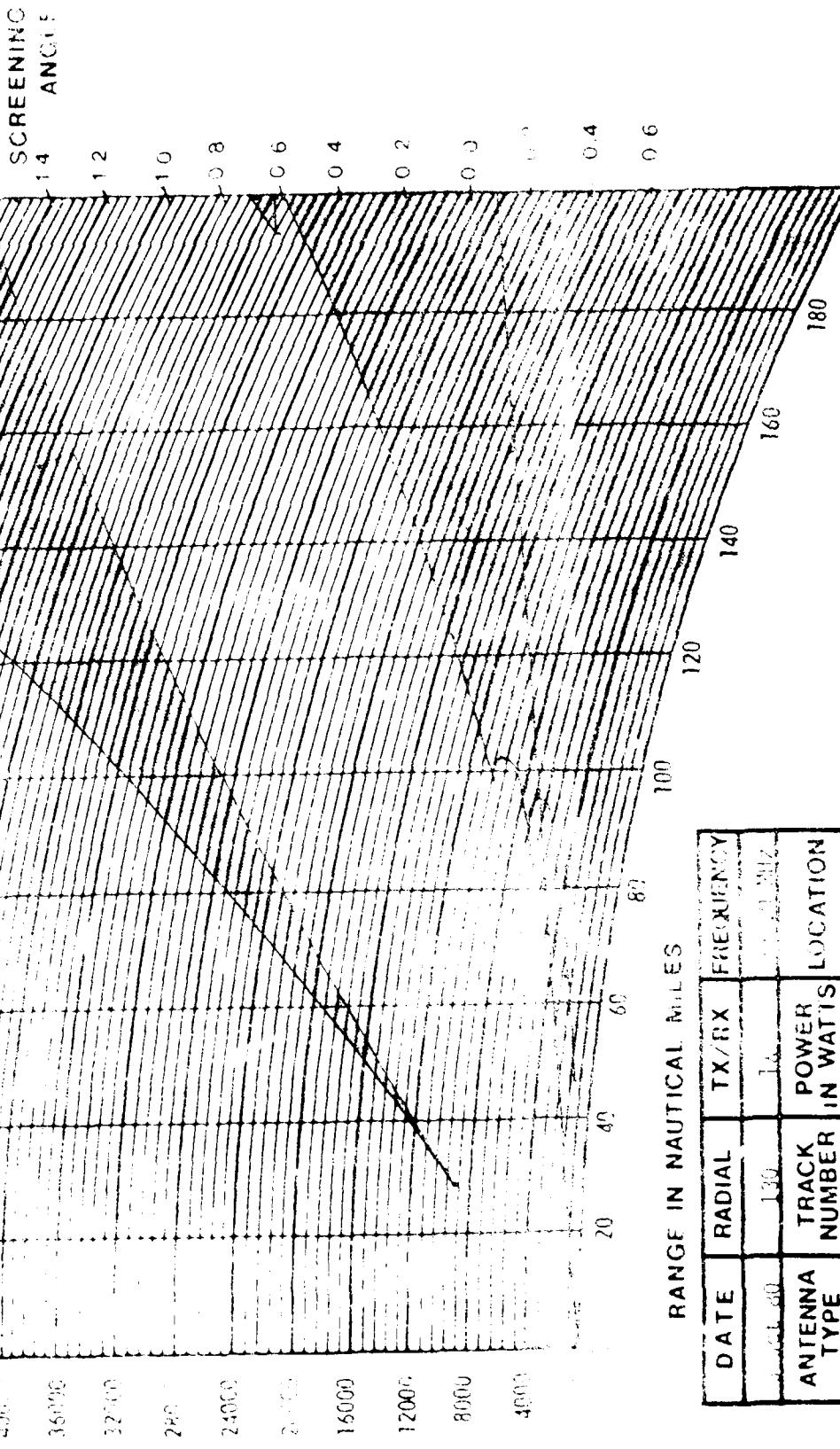


| DATE | RADIAL | TX/RX | FLIGHT DURATION |
|--------------|--------------|----------------|-----------------|
| 10/10/00 | 312 | TX | 100 min |
| ANTENNA TYPE | TRACK NUMBER | POWER IN WATTS | LOCATION |
| 10/10/00 | 312 | 100 | 1000 ft |

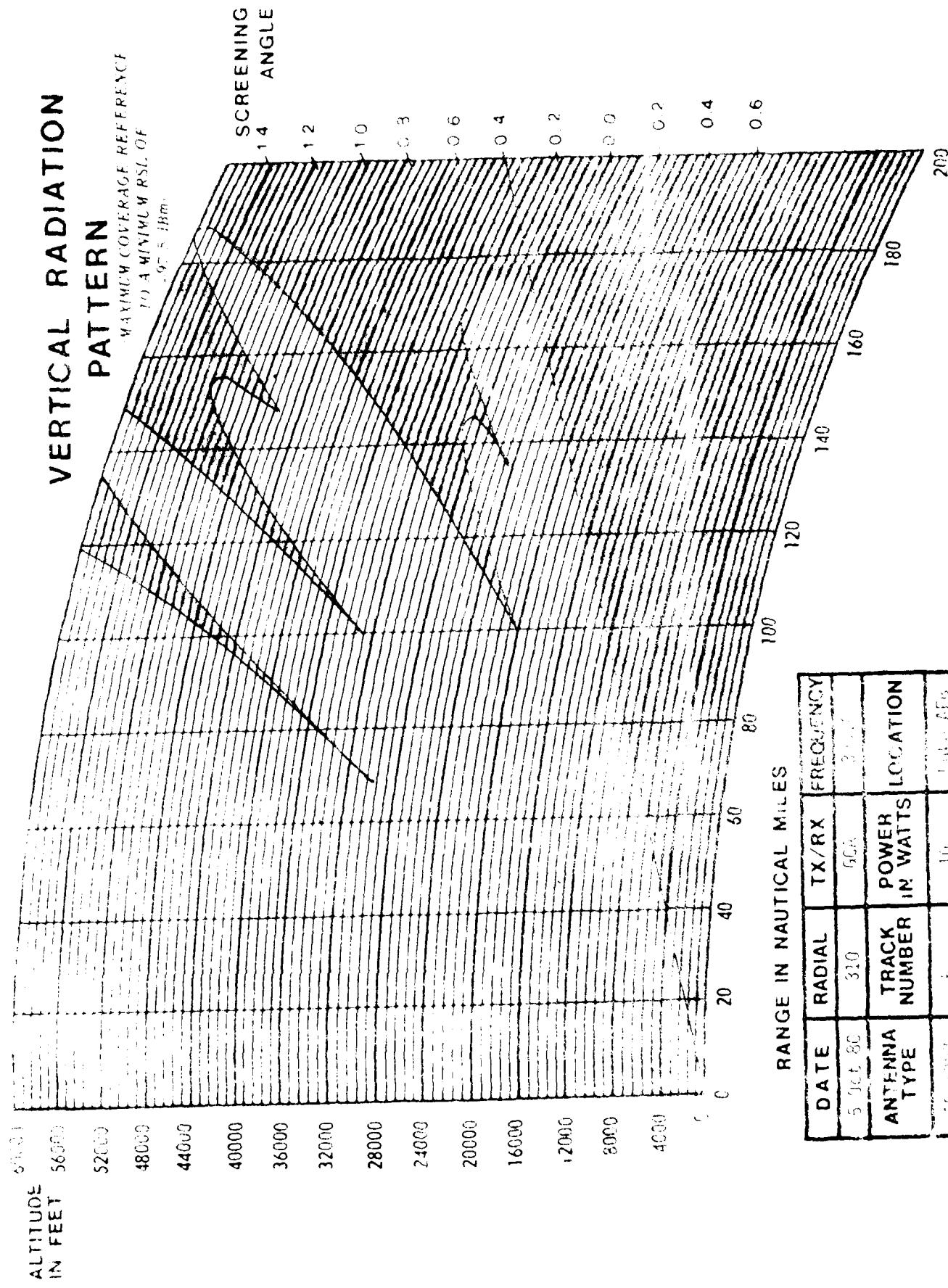
VERTICAL RADIATION PATTERN

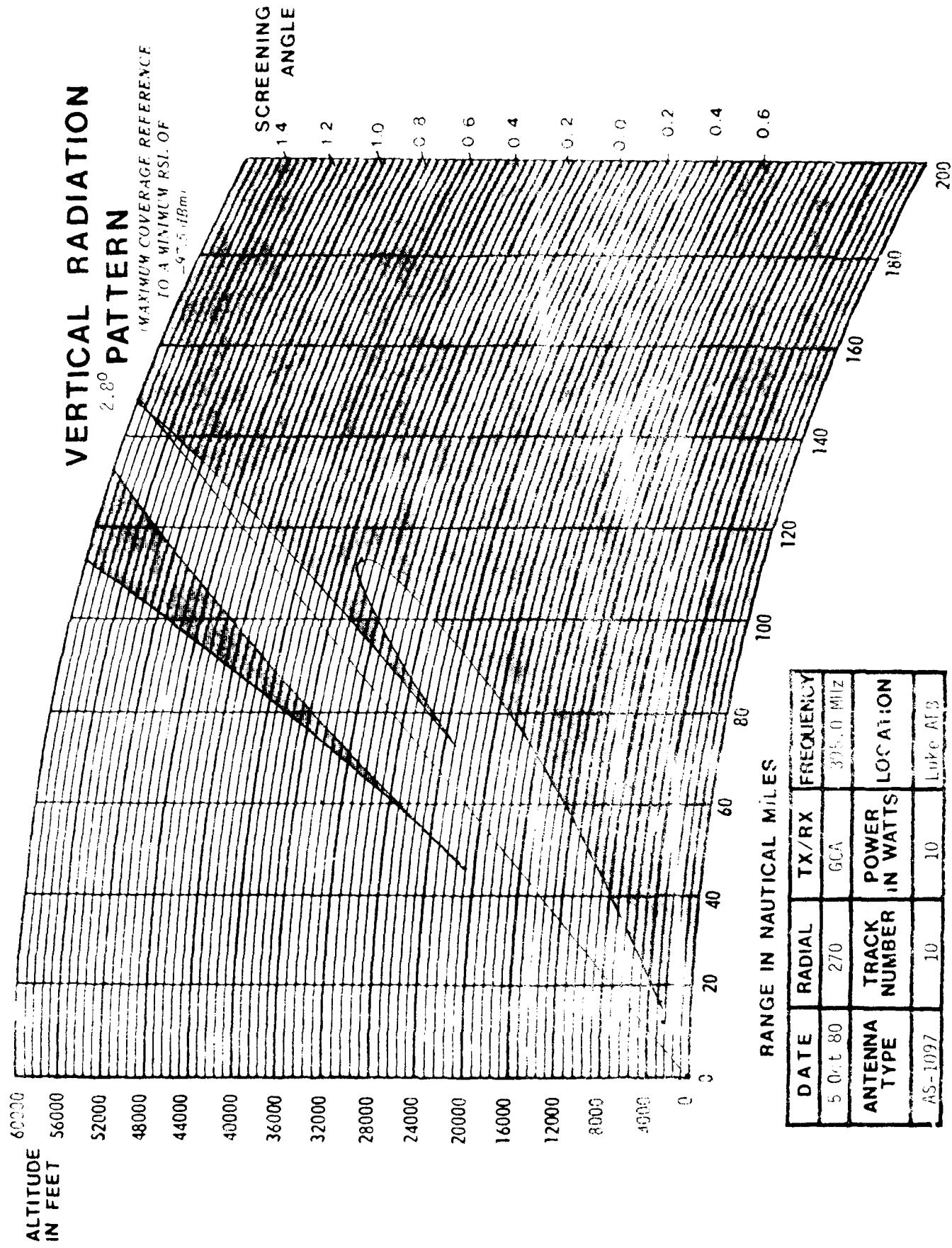
MAXIMUM COVERAGE DIFFERENCE
TO A MAXIMUM RSI OF

10 dB



| DATE | RADIAL | TX/RX | FREQUENCY |
|------------|--------|-------|-----------|
| 1961-09-14 | 130 | 14 | 10000 |
| | | | |





DATE
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